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## Concept Of The Month

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## Synoptic Glance

8 Block Elements  
Carbons-1

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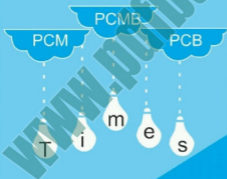
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# Syn-Anti Addition

## Concept of the month

*This column is aimed at preparing students for all competitive exams like JEE, NEET, BITSAT etc. Every concept has been designed by highly qualified faculty to cater to the needs of the students by discussing the most complicated and confusing concepts in Chemistry.*

By: P. BRAHMA REDDY  
(Alumni from IIT Delhi)

### Introduction

All alkenes have a common feature i.e., they contain a carbon-carbon double bond, consists of a strong  $\sigma$ -bond and a weak  $\pi$ -bond. The pair of electrons in the  $\pi$ -bond is less firmly held between the two carbon nuclei and is capable of being readily polarized. The property results in the reactivity characteristic of olefinic compounds. A carbon-carbon double bond which is electron-rich reacts with electrophile to give an addition product. These addition reactions proceed by a polar mechanism and have been recognised to

involve a carbocation intermediate in absence of light or peroxides.

Due to trigonal planar geometry of olefin carbon atoms the addition can occur on the same side (syn periplanar) or on opposite sides (anti periplanar).

- Syn addition is the addition of two substituents to the same side of the unsaturated molecule.
- Anti addition, on the other hand, is the addition of two substituents in opposite directions.

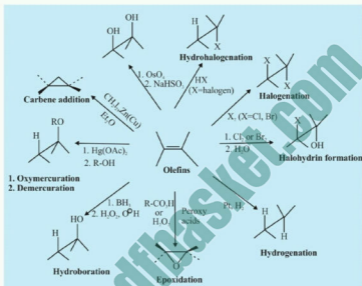
### SYN addition Vs ANTI addition

Syn addition is the addition of two substituents to the same side of an unsaturated molecule	Anti addition is the addition of two substituents to the opposite sides of an unsaturated molecule
Involves the addition of substituents to the same side of the double bond or the triple bond	Involves the addition of substituents to the opposite sides of the double bond or the triple bond
Ex: Oxidation of alkenes to diols in the presence of $\text{OsO}_4$	Ex: Halogenation of alkenes

### Similarities between Syn and Anti addition

- ◆ Both are types of addition reactions.
- ◆ Both reactions decrease the bond order around carbon atoms having a double or triple bond.
- ◆ Both types increase the number of substituents around carbon atoms having a double or triple bond.

## Examples of Syn and Anti addition



## ♦ Stereochemistry of Alkene addition reactions (Syn/Anti addition)

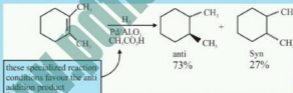
Reagents added to alkenes	Stereochemistry of addition	Stereoisomers formed
$\text{H}_2$ addition	Syn	Cis $\longrightarrow$ Erythro or Cis
Hydroxylation with $\text{KMnO}_4$	Syn	enantiomers***
Peroxy acid addition	Syn	Trans $\longrightarrow$ Threo or trans
Hydroboration-oxidation	Syn	enantiomers
$\text{OsO}_4$ addition (Diol formation)	Syn	

Halogen addition	Anti	Cis $\rightarrow$ Threo or trans enantiomers Trans $\rightarrow$ Erythro or Cis enantiomers***
HOX addition (Halohydrin formation)	Anti	
Addition of halogen + ROH	Anti	
Addition of reagents that form a carbocation intermediate	Syn or Anti	Four stereoisomers are formed; the cis and trans isomers each form the same products.

\*\*\*An acyclic compound forms the erythro enantiomers; a cyclic compound forms the cis enantiomers. If the two asymmetric centres have the substituents, a meso compound will be formed instead of the pair of erythro or cis enantiomer.

#### Anti vs Syn Stereoselectivity

- Although hydrogenation generally follows syn addition, special conditions exist that favour anti addition. In anti addition, one hydrogen atom adds to one face while the other adds to the other. The hydrogenation conditions shown in the reaction below exhibit **anti stereoselectivity**.
- The "anti" and "syn" products are diastereomers.
- The enantiomer of the anti product is not shown but is produced with equal preference to the anti isomer that is shown (i.e., of the 73% anti product, half of this amount is one enantiomer and half is the other). The syn product is a meso molecule.



#### KNOWLEDGE POINT

Cis - isomer + Syn addition	GIVES	Meso compound
Cis - isomer + Anti addition	GIVES	Racemic mixture
Trans - isomer + Syn Addition	GIVES	Racemic mixture
Trans - isomer + Anti addition	GIVES	Meso compound

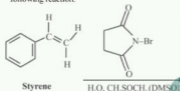
**\*\*Remember like CAR (Cis - Anti - Racemic)**



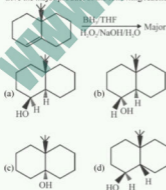
## Exercise

### Section A: Only one option correct

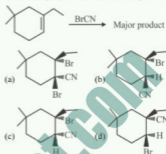
- Which of the following compound is/are formed as a sole product during the bromination of cyclopentene?
  - trans-1,2-Dibromocyclopentane
  - cis-1,2-Dibromocyclopentane
  - Racemic mixture of 1,2-Dibromocyclopentane
  - Meso form of 1,2-Dibromocyclopentane
- Identify the major product formed during the following reaction.



- 2-Bromo-1-methylphenol
  - 2-Bromo-1-phenylethanol
  - 1-Phenyl-2-bromoethanol
  - 1,2-Dibromo-1-phenylethane
- 1-Methylcyclopentene upon hydroboration-oxidation produces major as
    - cis-2-Methylcyclopentane
    - trans-2-Methylcyclopentanol
    - cis-2-Methylcyclopentanol
    - Racemic mixture
  - Give the major product of the following reaction



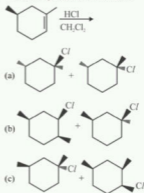
- Give the major product of the following reaction

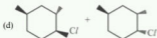


- Which of the following reagent will bring about the following transformation?

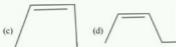
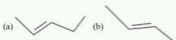


- $\text{Cl}_2/\text{H}_2\text{O}$
  - $\text{PBr}_3/\text{H}^+$
  - $\text{Hg}(\text{OAc})_2/\text{H}^+$
  - Hydroboration-oxidation
- What is the product of the reaction?

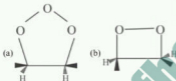




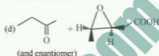
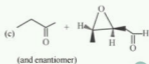
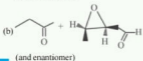
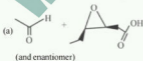
8. Which alkenes would yield a meso compound upon treatment with  $\text{OsO}_4, \text{NaHSO}_3, \text{H}_2\text{O}$ ?



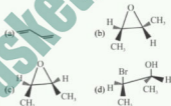
9. The first intermediate formed in the ozonolysis of trans-2-butene is



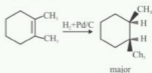
10. Give the major product of the following reaction sequence



11. The major product of the following sequence of reaction is



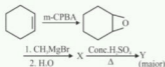
12. Choose the incorrect statement about the following catalytic hydrogenation



- (a) The minor product occurs as the result of a catalyzed isomerization of the reactant  
(b) The minor trans isomer is actually present as a racemic mixture  
(c) The syn addition of  $\text{H}_2$  gives the cis isomer as the major product  
(d) The catalyst (Pd/C) speeds up the reaction by stabilizing the major product of the reaction

## Section B: More than one option correct

13. Consider the reaction sequence below



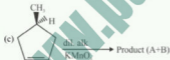
The correct statement is/are

- (a) The major product Y is 1-Methyl cyclohexene  
 (b) X is a racemic mixture  
 (c) X is a single pure enantiomer  
 (d) Y is 2-Methyl cyclohexene

## Section C: Comprehension type questions

## Passage 1

In the given reactions



14. For the given reaction (i), X and Y are

- (a) Meso compounds (b) Diastereomers  
 (c) Identical (d) Enantiomers

15. For the given reaction (iv), products M and N are

- (a) Enantiomers (b) Diastereomers  
 (c) Identical (d) Meso compound

16. Which of the following is a correct statement ?

- (a) Products A and B are Diastereoisomers

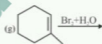
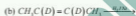
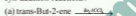
(b) Products P and Q are enantiomers

(c) Products A and B are identical

(d) Products P and Q are identical

## Section D: Integer type questions

17. How many of the following addition reactions are syn addition reactions?

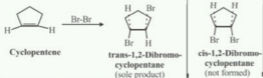


## ANSWER KEY

- |       |       |          |       |       |
|-------|-------|----------|-------|-------|
| 1. a  | 2. b  | 3. b     | 4. b  | 5. d  |
| 6. d  | 7. a  | 8. c     | 9. c  | 10. a |
| 11. c | 12. b | 13. a, b | 14. d | 15. b |
| 16. a | 17. 3 |          |       |       |

## HINTS &amp; SOLUTIONS

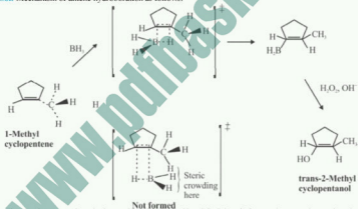
**1.Sol:** When the bromination reaction is carried out on a cyclopentene, only the trans stereoisomer of the dihalide addition product is formed, rather than the mixture of cis and trans isomers that might have been expected if a planar carbocation intermediate were involved.



**2.Sol:** The product during the given reaction is



**3.Sol:** Mechanism of alkene hydroboration as follows:



The reaction occurs in a single step in which the C-H and C-B bonds form at the same time and on the same face of the double bond. The lower energy, more rapidly formed transition state is the one with less steric crowding, leading to non-Markovnikov regiochemistry.

**4.Sol:** Syn addition reaction.

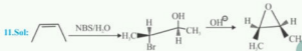
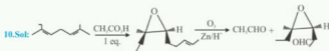
**5.Sol:** Anti addition and Markovnikov's product.

**6.Sol:** Syn addition.

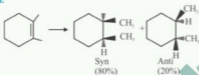
**7.Sol:** Markovnikov's addition of HCl.

**8.Sol:**  $\text{OsO}_4$  gives syn hydroxylation of alkene. Hence, a cis, symmetrical alkene would give meso diol.

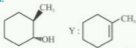
**9.Sol:** Syn ozonation occur to give ozonide.



12.Sol:

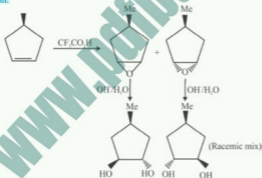


13.Sol:

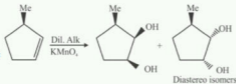


Racemic mixture

14.Sol:



15.Sol:




17.Sol: (b), (c), (e) are examples.

## GLIMPSE


## THE ELITE SERIES

## HYDROGEN PEROXIDE


- Hydrogen peroxide is manufactured by the autoxidation of
  - 2-ethylanthraquinol
  - Anthraquinone
  - Naphthalene
  - Anthracene
- $H_2O_2$  is prepared in the laboratory when
  - $MnO_2$  is added to dilute cold  $H_2SO_4$
  - $BaO_2$  is added to  $CO_2$  bubbling through cold water
  - $PbO_2$  is added to an acidified solution of  $KMnO_4$
  - $Na_2O_2$  is added to boiling water
- Hydrogen peroxide is not
  - A reducing agent
  - An oxidising agent
  - A dehydrating agent
  - A bleaching agent
- The bleaching properties of  $H_2O_2$  are due to its
  - Reducing properties
  - Oxidising properties
  - Unstable nature
  - Acidic nature
- Hydrogen peroxide has a
  - Linear structure
  - Pyramidal structure
  - Closed book type structure
  - Half open book type structure
- Which of the following is a true structure of  $H_2O_2$ ?
 




(a)  $H-O-O-H$



(b)  $H-O-O-H$



(c)  $H-O-O-H$



(d)  $H-O-O-H$
- The volume of oxygen liberated from 15 ml of 20 volume of  $H_2O_2$  is
  - 250 ml
  - 300 ml
  - 150 ml
  - 200 ml
- The product of the reaction between  $H_2O_2$  and  $Cl_2$  is
  - $O_2 + HOCl$
  - $2HCl + O_2$
  - $H_2O + HCl$
  - $HCl + H_2$
- The hybridization and oxidation state of two O atoms in hydrogen peroxide are respectively
  - $sp^2, -1$
  - $sp^3, +1$
  - $sp^3, -1$
  - $sp^2, +1$
- The percentage of  $H_2O_2$  in 1.5 N solution is
  - 3.6
  - 2.99
  - 2.55
  - 2.4
- $H_2O_2$  in rocket fuel acts as
  - A propellant
  - An oxidising agent
  - both (a) & (b)
  - none
- A commercial sample of hydrogen peroxide is labeled as "10 volume". Its percentage strength is nearly
  - 1%
  - 3%
  - 10%
  - 90%
- $H_2O$  and  $H_2O_2$  resemble in
  - Hybridization of oxygen
  - Oxidation state of oxygen
  - structure
  - bond angle
- Moist  $H_2O_2$  cannot be dried over concentrated  $H_2SO_4$  because
  - It can catch fire
  - It is reduced by  $H_2SO_4$
  - it is oxidized by  $H_2SO_4$

- (d) none of these is true
15. Which one of the following is an example of interstitial hydride?  
(a)  $NH_3$  (b)  $CH_4$  (c)  $ZnH_2$  (d)  $H_2O$
16. Which of the following equation depicts reducing nature of  $H_2O_2$ ?  
(a)  $2[Fe(CN)_6]^{4-} + 2H^+ + H_2O_2 \rightarrow 2[Fe(CN)_6]^{3-} + 2H_2O$   
(b)  $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$   
(c)  $Mn^{2+} + H_2O_2 \rightarrow Mn^{4+} + 2OH^-$   
(d)  $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$
17. Hydrogen peroxide cannot be concentrated easily because  
(a) It is highly volatile in nature  
(b) It is not miscible with water  
(c) It decomposes at its boiling point  
(d) It has a very high boiling point
18. A colourless liquid 'A' contains H and O elements only. It decomposes slowly on exposure to light. It is stabilised by mixing urea to store in the presence of light. 'A' is  
(a) HO (b)  $H_2O$   
(c)  $H_2O_2$  (d) Can't be predicted
19. Decomposition of  $H_2O_2$  is retarded by  
(a)  $H_3PO_4$  (b) Alcohol  
(c) Acetamide (d) All
20. 100 cm<sup>3</sup> of a given sample of  $H_2O_2$  gives 1000 cm<sup>3</sup> of  $O_2$  at S.T.P. The given sample is  
(a) 10%  $H_2O_2$  (b) 90%  $H_2O_2$   
(c) 10 volume  $H_2O_2$  (d) 100 volume  $H_2O_2$
21. Which of the following cannot be oxidised by  $H_2O_2$ ?  
(a)  $KI + HCl$  (b)  $O_3$   
(c)  $PbS$  (d)  $Na_2SO_3$
22. In which of the following reactions,  $H_2O_2$  is acting as a reducing agent?  
(a)  $H_2O_2 + SO_2 \rightarrow H_2SO_4$   
(b)  $2KI + H_2O_2 \rightarrow 2KOH + I_2$   
(c)  $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$   
(d)  $Ag_2O + H_2O_2 \rightarrow 2Ag + H_2O + O_2$
23. Consider the reactions  
(A)  $H_2O_2 + 2HI \rightarrow I_2 + 2H_2O$   
(B)  $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$   
Which of the following statement is correct about  $H_2O_2$  with reference to these reactions? Hydrogen peroxide is  
(a) An oxidising agent in both (A) and (B)  
(b) An oxidising agent in (A) and reducing agent in (B)  
(c) A reducing agent in (A) and oxidising agent in (B)  
(d) A reducing agent in both (A) and (B)
24. The molarity of a 100 ml solution containing 5.1 g of hydrogen peroxide is  
(a) 0.15 M (b) 1.5 M  
(c) 3.0 M (d) 50.0 M
25. Calculate the mass of oxygen which will be liberated by the decomposition of 200 mL of 5M hydrogen peroxide solution.  
(a) 8 g (b) 16 g (c) 24 g (d) 32 g
26. The strength (in g/lit) of 10 volume solution of hydrogen peroxide is  
(a) 34 (b) 30 (c) 26 (d) 22
27. Which of the following equations depict the oxidising nature of  $H_2O_2$ ?  
(a)  $2MnO_4^{2-} + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$   
(b)  $2Fe^{2+} + 2H^+ + H_2O_2 \rightarrow 2Fe^{3+} + 2H_2O + O_2$   
(c)  $2I^- + 2H^+ + H_2O_2 \rightarrow I_2 + 2H_2O$   
(d)  $KIO_4 + H_2O_2 \rightarrow KIO_3 + H_2O + O_2$
28. Decomposition of  $H_2O_2$  is retarded by  
(a)  $H_3PO_4$  (b) alcohol  
(c) acetamide (d) all of these
29. "Perhydrol" is a solution of  
(a) 50%  $H_2O_2$  solution  
(b) 70%  $H_2O_2$  solution  
(c) 30%  $H_2O_2$  solution  
(d) 100% Pure  $H_2O_2$  solution
30. Hydrogen peroxide is now generally prepared on industrial scale by the  
(a) Action of  $H_2SO_4$  on barium peroxide  
(b) Action of  $H_2SO_4$  on sodium peroxide  
(c) Electrolysis of 50%  $H_2SO_4$   
(d) Burning hydrogen in excess of oxygen

31.  $H_2O_2$  restores the colour of old oily paintings, blackened by the action of  $H_2S$  gas by  
 (a) Converting  $PbO_2$  to  $Pb$   
 (b) By oxidising  $PbS$  to  $PbSO_4$   
 (c) Converting  $PbCO_3$  to  $Pb$   
 (d) Oxidising  $PbSO_4$  to  $PbSO_4$
32. Which of the following reaction depicts oxidising nature of  $H_2O_2$ ?  
 (a)  $2MnO_4^{2-} + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$   
 (b)  $2Fe^{3+} + 2H^+ + H_2O_2 \rightarrow 2Fe^{2+} + 8H_2O + O_2$   
 (c)  $2I^- + 2H^+ + H_2O_2 \rightarrow I_2 + 2H_2O$   
 (d)  $KIO_4 + H_2O_2 \rightarrow KIO_3 + H_2O + O_2$
33. When hydrogen peroxide is added to acidified potassium dichromate blue color is produced due to the formation of  
 (a)  $CrO_3$  (b)  $Cr_2O_3$  (c)  $CrO_5$  (d)  $CrO_4^{2-}$
34. The volume strength of 3.57 M solution of hydrogen peroxide is  
 (a) 30 volume (b) 40 volume  
 (c) 20 volume (d) 25 volume
35. The volume of 20 volume  $H_2O_2$  solution that decolourises 200 mL of 2N  $KMnO_4$  solution in acidic medium is  
 (a) 112 mL (b) 336 mL  
 (c) 200 mL (d) 224 mL
36. How does  $H_2O_2$  differ from  $O_3$  in its chemical action?  
 (a) In oxidising  $PbS$  to  $PbSO_4$   
 (b) In liberating  $J_2$  from  $KI$   
 (c) In decolourising acidified  $KMnO_4$   
 (d) In oxidising  $K_4[Fe(CN)_6]$  to  $K_3[Fe(CN)_6]$
37. Hydrolysis of one mole of peroxydisulphuric acid produces  
 (a) two moles of sulphuric acid  
 (b) two moles of peroxymonosulphuric acid  
 (c) one mole of sulphuric acid and one mole of peroxy-monosulphuric acid  
 (d) one mole of sulphuric acid, one mole of peroxymonosulphuric acid and one mole of hydrogen peroxide
38. A hydride of nitrogen which is acidic in nature is  
 (a)  $NH_3$  (b)  $N_2H_4$  (c)  $N_2H_2$  (d)  $N_3H$
39. To 8.4 mL  $H_2O_2$ , excess of acidified solution of  $KI$  was added. The iodine liberated required 20 mL of 0.3 N  $Na_2S_2O_3$  solution. Volume strength of  $H_2O_2$  solution is  
 (a) 2 (b) 3 (c) 4 (d) 5
40. 100 mL of tap water containing  $Ca(HCO_3)_2$  was titrated with N/50  $HCl$  with methyl orange as indicator. If 30 mL of  $HCl$  were required, the temporary hardness as parts of  $CaCO_3$  per 10<sup>6</sup> parts of water is  
 (a) 150 ppm (b) 300 ppm  
 (c) 450 ppm (d) 600 ppm
41. Which is not chromium hydroxide is treated with  $H_2O_2$  in the presence of  $NaOH$   
 (a)  $Cr(OH)_3$  precipitate is converted into soluble sodium chromate  
 (b) The solution acquires yellow colour  
 (c) oxidation state of  $Cr^{3+}$  is changed to  $Cr^{6+}$   
 (d)  $H_2O_2$  acts as a reducing agent
42. Dihydrogen on reaction with oxygen gives water and the reaction is  
 (a) highly exothermic (b) highly endothermic  
 (c) explosive (d) nuclear.
43. On earth hydrogen is rarely found in its uncombined state because  
 (a) It is highly inflammable  
 (b) It combines with oxygen to give water  
 (c) The earth's gravity is too weak to hold such light molecules  
 (d) It has three isotopes.

## ANSWER KEY

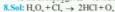
- |       |       |       |       |       |
|-------|-------|-------|-------|-------|
| 1. a  | 2. b  | 3. c  | 4. b  | 5. d  |
| 6. b  | 7. b  | 8. b  | 9. c  | 10. c |
| 11. c | 12. b | 13. a | 14. c | 15. c |
| 16. b | 17. c | 18. c | 19. d | 20. c |
| 21. b | 22. d | 23. b | 24. b | 25. b |
| 26. b | 27. c | 28. d | 29. c | 30. c |
| 31. b | 32. c | 33. c | 34. b | 35. a |
| 36. c | 37. c | 38. d | 39. c | 40. b |
| 41. d | 42. a | 43. c |       |       |

## HINTS &amp; SOLUTIONS



7. Sol: 20 volume means 1 ml of  $\text{H}_2\text{O}_2$  gives 20 ml of  $\text{H}_2\text{O}_2$

15 ml of  $\text{H}_2\text{O}_2$  gives =  $15 \times 20 = 300$  ml of  $\text{O}_2$



10. Sol: 1.75 N  $\text{H}_2\text{O}_2 = 3.03\% \text{ w/v}$

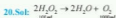
12. Sol: 10 vol  $\text{H}_2\text{O}_2 = 3.03\% \text{ w/v}$

13. Sol: In both, oxygen is  $\text{sp}^3$  hybridised

16. Sol: In reducing properties  $\text{O}_2$  is released

17. Sol:  $\text{H}_2\text{O}_2$  decomposes at its b.p. and therefore, cannot be concentrated by heating at high temperature.

19. Sol: Acetanilide, alcohol and  $\text{H}_3\text{PO}_4$  are negative catalyst for decomposition of  $\text{H}_2\text{O}_2$ .



or 1 ml of  $\text{H}_2\text{O}_2$  will give 10 ml of  $\text{O}_2$  at STP.

Thus its volume strength is 10 volume.

21. Sol:  $\text{O}_3$  is more powerful oxidising agent than  $\text{H}_2\text{O}_2$ .

So,  $\text{H}_2\text{O}_2$  reduces  $\text{O}_3$  to  $\text{O}_2$



24. Sol:  $M = \frac{5.1 \times 1000}{34 \times 100} = 1.5$

25. Sol:  $5 = \frac{Wt \times 1000}{34 \times 200}$  (from Molarity)

Wt. of  $\text{H}_2\text{O}_2 = 34 \text{ g}$



Thus 34 g of  $\text{H}_2\text{O}_2$  gives 16 g of  $\text{O}_2$ .

26. Sol: 10 volume solution of  $\text{H}_2\text{O}_2$  means that 1L of this  $\text{H}_2\text{O}_2$  solution will give 10 L of oxygen at STP



2 x 34 g      22.4 L at STP

68 g

On the basis of above equation 22.4 L of  $\text{O}_2$  is produced from 68 g  $\text{H}_2\text{O}_2$  at STP 10 L of  $\text{O}_2$  at STP is produced from

$$\frac{68 \times 10}{22.4} \text{ g} = 30.3 \text{ g} \quad 30 \text{ g } \text{H}_2\text{O}_2$$

Therefore, strength of  $\text{H}_2\text{O}_2$  in 10 volume  $\text{H}_2\text{O}_2$  solution = 30 g/L = 3%  $\text{H}_2\text{O}_2$  solution

27. Sol: In oxidising properties  $\text{H}_2\text{O}_2$  is formed.

28. Sol: Acetanilide, alcohol and  $\text{H}_3\text{PO}_4$  are negative catalysts and retard decomposition of  $\text{H}_2\text{O}_2$ .



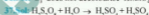
32. Sol:  $\text{I}^-$  undergoes oxidation and  $\text{H}_2\text{O}_2$  undergo reduction.

33. Sol:  $\text{CrO}_3$  is formed

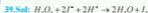
34. Sol: Volume strength =  $M \times 11.2 = 3.57 \times 11.2 = 40$  volume

35. Sol: Normality of 20 volume  $\text{H}_2\text{O}_2 = 20/5.6 = 3.57 \text{ N}$   
 $3.57 \times V = 2 \times 200$   
 $V = 112 \text{ mL}$

36. Sol:  $\text{O}_3$  does not decolourise  $\text{KMnO}_4$ .



38. Sol:  $\text{N}_3\text{H}$  (hydrazoic acid) is the acidic hydride of nitrogen.



$$\frac{N_1 V_1}{(M_1 \rho_1)} = \frac{N_2 V_2}{(M_2 \rho_2)}$$

$$N_1 \times 8.4 = 0.3 \times 20 \Rightarrow N_1 = 0.7143$$

Now, volume strength = normality  $\times 5.6$

$$\Rightarrow \text{Volume strength} = 0.7143 \times 5.6 = 4$$



$$= 30 \text{ mL N/50 } \text{CaCO}_3 = 100 \text{ mL tap water}$$

$$\text{Mass of } \text{CaCO}_3 \text{ in 100 mL tap water} = \frac{E \times N \times V}{1000}$$

$$= \frac{50 \times 30}{50 \times 1000} = 0.03 \text{ g} \Rightarrow \text{Hardness} = 300 \text{ ppm}$$

41. Sol:  $\text{H}_2\text{O}_2$  oxidises  $\text{Cr}^{3+}$  to  $\text{Cr}^{6+}$

## MOCK TEST PAPER

2019

NEET - 3

2018

- An isotope of  $^{76}_{32}\text{Ge}$  is
  - $^{77}_{32}\text{Ge}$
  - $^{77}_{31}\text{As}$
  - $^{77}_{34}\text{Se}$
  - $^{78}_{34}\text{Se}$
  - Only (i) and (ii)
  - Only (ii) and (iii)
  - Only (ii) and (iv)
  - Only (ii), (iii) and (iv)
- Two particles A and B are in motion. If the wavelength associated with the particle A is  $5 \times 10^{-8} \text{ m}$ , calculate the wavelength of particle B if its momentum is half of A.
  - $10^{-8} \text{ m}$
  - $10^{-6} \text{ m}$
  - $10^{-4} \text{ m}$
  - $10^{-3} \text{ m}$
- In which of the following molecules/ions, the central atom does not involve a d-orbital in the hybridisation process?
  - $\text{I}_3^+$
  - $\text{SF}_6$
  - $[\text{Cu}(\text{NH}_3)_4]^{2+}$
  - $\text{ClO}_4^-$
- The correct sequence of polarity of the following molecule (P = Polar and NP = Non-polar)
  - Benzene
  - Inorganic Benzene
  - $\text{PCl}_2\text{F}_2$
  - $\text{PCl}_2\text{F}_3$

I	II	III	IV
(a) P	NP	NP	P
(b) NP	NP	NP	P
(c) NP	P	NP	P
(d) NP	P	P	NP
- KF combines with HF to form  $\text{KHF}_2$ . The compound contains the species
  - $\text{K}^+$ ,  $\text{F}^-$  and  $\text{H}^+$
  - $\text{K}^+$ ,  $\text{F}^-$  and HF
  - $\text{K}^+$  and  $[\text{HF}_2]^-$
  - $[\text{KHF}]^+$  and  $\text{F}_2$
- A gas occupies 300 ml at  $27^\circ\text{C}$  and 730 mm pressure. What would be its volume at STP?
  - 162.2 ml
  - 262.2 ml
  - 362 ml
  - 462.2 ml
- At what temperature will the rate of diffusion of  $\text{N}_2$  be 1.6 times the rate of diffusion of  $\text{SO}_2$  at  $27^\circ\text{C}$ ?
  - $336^\circ\text{C}$
  - $300^\circ\text{C}$
  - $50^\circ\text{C}$
  - $63^\circ\text{C}$
- The reciprocal of viscosity can be termed as
  - Surface tension
  - Fluidity
  - Density
  - Elasticity
- The pressure on a sample of water at its triple point is reduced while the temperature is held constant. Which phase changes are favoured?
  - Melting of ice
  - Sublimation of ice
  - Vaporization of liquid water
  - I only
  - III only
  - II only
  - II and III
- The formula to find pH of the aqueous solution of an amphoteric salt  $\text{NaHS}$  is
  - $[\text{p}K_a + \text{p}K_a]$
  - $1/2[\text{p}K_a + \text{p}K_a]$
  - $[\text{p}K_a - \text{p}K_a]$
  - $1/2[\text{p}K_a - \text{p}K_a]$
- At a particular temperature
 
$$\text{H}^+_{(\text{aq})} + \text{OH}^-_{(\text{aq})} \rightarrow \text{H}_2\text{O}_{(\text{l})}; \Delta H = -57.1 \text{ kJ}$$
 The approximate heat evolved when 400 mL of 0.2 M  $\text{H}_2\text{SO}_4$  is mixed with 600 mL of 0.1 M KOH solution will be
  - 3.426 kJ
  - 13.7 kJ
  - 5.2 kJ
  - 55 kJ
- The quantities which are not taken as zero for elementary substances are
  - Standard enthalpy of formation
  - Standard free energy of formation
  - Standard heat content
  - Standard entropy of formation
- Which of the following has maximum C - H bond length?
  - $\text{C}_2\text{H}_4$
  - $\text{C}_2\text{H}_2$
  - $\text{C}_2\text{H}_6$
  - $\text{C}_2\text{H}_8$

14. The IUPAC name of  is

- (a) Bicyclo [3,2,0] hexan-2-ol  
(b) Spiro [3,2] hexan-1-ol  
(c) Spiro [3,2] hexan-4-ol  
(d) Spiro [2,3] hexan-4-ol

15. Number of isomeric forms of  $C_7H_8N$  having benzene ring will be

- (a) 7 (b) 6 (c) 5 (d) 4

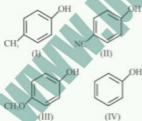
16. Metamers of ethylpropionate are

- (a)  $C_4H_8COOH$  and  $HCOOC_4H_9$   
(b)  $C_4H_8COOH$  and  $CH_3OOC_3H_7$   
(c)  $CH_3COOCH_3$  and  $CH_3OOC_2H_5$   
(d)  $CH_3COOC_2H_5$  and  $C_4H_8COOCH_3$

17. 0.257 g of an organic substance was heated with conc  $H_2SO_4$  and then distilled with excess of strong alkali. The ammonia gas evolved was absorbed in 50 ml of N/10 HCl which required 23.2 ml of N/10 NaOH for neutralisation at the end of the process. The percentage of nitrogen in the compound is-

- (a) 14.6 (b) 18.0 (c) 17.0 (d) 15.5

18. Identify the correct order of acidic strength of the following compounds



- (a) I < III < I < IV (b) II > I > IV > III  
(c) I > III > IV > II (d) II > IV > I > III

19. A mixture of naphthalene and benzoic acid can be separated by

- (a) Extraction with solvent  
(b) Sublimation  
(c) Fractional crystallisation  
(d) Distillation

20. Find the correct statement/s

- i) Magnetic moment of  $Mn^{2+}$  ion is  $\sqrt{35}$   
ii)  $Ti^{4+}$  exhibits purple colour  
iii) 1 Bohr Magnetron =  $9.273 \times 10^{-24}$  J. Tesla<sup>-1</sup>  
iv)  $V_2O_5$  is used as catalyst in Contact process  
(a) Only i is correct (b) Only ii is correct  
(c) i, iii, iv are correct (d) All are correct

21. In the series Sc ( $Z=21$ ) to Zn ( $Z=30$ ), the enthalpy of atomisation of zinc is the lowest, i.e., 126 kJ mol<sup>-1</sup>. Why?

- (a) No 3d electrons involve in metallic bond  
(b) It is not a transition element  
(c) It has pseudo inert gas configuration in +2 state  
(d) It is soft metal

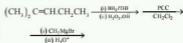
22. When orange solution containing  $Cr_2O_7^{2-}$  ion is treated with an alkali, a yellow solution is formed and when  $H^+$  ions are added to yellow solution, an orange solution is obtained. Explain why does this happen?

- (a)  $Cr_2O_7^{2-}$  changes to  $CrO_4^{2-}$  in basic medium  
(b)  $CrO_4^{2-}$  changes to  $Cr_2O_7^{2-}$  in acid medium  
(c) Both are in equilibrium hence addition of acid or base shift the equilibrium, hence the colour change.  
(d) All the above.

23. Primary alcohol can easily be prepared from primary alkyl halide via  $S_N2$  reaction with aqueous NaOH. However, similar method does not work for the preparation of tertiary alcohol (tertiary butanol) from tertiary butyl bromide except

- (a)  $(CH_3)_3CBr \xrightarrow{(i) KOH/EtOH} \xrightarrow{(ii) H_2O/HCl}$   
(b)  $(CH_3)_3CBr \xrightarrow{(i) H_2O/HCl} \xrightarrow{(ii) H_2O/HCl}$   
(c)  $(CH_3)_3CBr + KOH \xrightarrow{C_2H_5OH} \xrightarrow{H_2SO_4/AcOH}$   
(d)  $(CH_3)_3CBr + CH_3COOAg(aq) \xrightarrow{H_2O}$

24. What is the product of the following sequence of reactions?



- (a) 2,4-Dimethyl-3-pentanol  
(b) 2,3-Dimethyl-3-pentanol  
(c) 2,3-Dimethyl-2-pentanol  
(d) 2,2-Dimethyl-3-pentanol

25. The missing structure A and B in the reaction sequences:



$RCHO + A, RCHO \xrightarrow{\text{reduction}} B$ ; are

- (a) Methanal,  $RCH_2OH$  (b) Methanal,  $RCHOHR$   
 (c)  $CH_3OH, RCOOH$  (d) Ethanal,  $RCOOH$   
 26. The IUPAC nomenclature of malonic acid is  
 (a) ethane-1,2-dioic acid  
 (b) propane-1,3-dioic acid  
 (c) butane-1,2-dioic acid  
 (d) butane-1,4-dioic acid  
 27. The products (A) and (B) in the following reactions are respectively



- (a)  $PhCH_2CHO, PhCH_2CH_2OH$   
 (b)  $PhC \equiv CNa, PhCOCH_3$   
 (c)  $PhC \equiv CH, PhCH_2CHO$   
 (d)  $PhCHICHCH_3, PhCOCHO$   
 28. Which of the following processes of metallurgy involves adsorption?  
 (a) Magnetic separation method  
 (b) Electrostatic separation method  
 (c) Gravity separation method  
 (d) Froth floatation process

29. 400ml of standard sol is just prevented from coagulation by the addition of 0.96 gm of starch before adding 1ml of 10% NaCl solution, the gold number will be  
 (a) 2.4 (b) 7.6 (c) 240 (d) 24

30. Which of the following processes makes use of electrolysis?  
 (a) Electrowinning (b) Electroplating  
 (c) Both (a) and (b) (d) None of these

31. The reduction potential of a half-cell consisting of a Pt electrode immersed in 1.5 M  $Fe^{2+}$  and 0.015 M  $Fe^{3+}$  solution at  $25^\circ C$  is  
 $(E^\circ_{Fe^{3+}/Fe^{2+}} = 0.770V)$  is  
 (a) 0.850 V (b) 0.710 V  
 (c) 0.652 V (d) 0.88 V

32. The rate equation for the reaction  $2A + B \rightarrow C$  is found to be:  $rate = k[A][B]$ . The correct statement

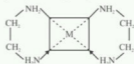
in relation to this reaction is

- (a) Unit of  $k$  must be  $s^{-1}$   
 (b)  $t_{1/2}$  is a constant  
 (c) Rate of formation of C is twice the rate of disappearance of A  
 (d) Value of  $k$  is independent of the initial concentrations of A and B.  
 33. In a first order reaction, 75% of the reactant disappeared in 1.386 hours. The rate constant of the reaction is  
 (a)  $3.6 \times 10^{-3} \text{ sec}^{-1}$  (b)  $2.8 \times 10^{-4} \text{ sec}^{-1}$   
 (c)  $8.2 \times 10^{-4} \text{ sec}^{-1}$  (d)  $1.8 \times 10^{-3} \text{ sec}^{-1}$   
 34. Match the items of Column I and Column II
- | Column I            | Column II           |
|---------------------|---------------------|
| A. Solid in gas     | 1. Brass            |
| B. Solid in solid   | 2. Amalgam          |
| C. Liquid in solid  | 3. Camphor in air   |
| D. Liquid in liquid | 4. Alcohol in water |
- Which of the following is correct?  
 (a) A-3, B-1, C-2, D-4  
 (b) A-1, B-3, C-4, D-2  
 (c) A-3, B-2, C-1, D-4  
 (d) A-4, B-1, C-2, D-3

35. A solution is obtained by mixing 300g of 25% solution and 400g of 40% solution by mass. The mass percentage of the resulting solution is:  
 (a) 66.66% (b) 3.36% (c) 33.6% (d) 22.4%

36.  $P_A$  and  $P_B$  are vapour pressure of pure liquid components, A and B respectively of an ideal binary solution. If  $X_A$  represents the mole fraction of component A, the total pressure of the solution will be  
 (a)  $P_A + X_A(P_A - P_B)$  (b)  $P_B + X_A(P_A - P_B)$   
 (c)  $P_A + X_A(P_B - P_A)$  (d)  $P_B + X_A(P_B - P_A)$

37. The correct IUPAC name of the complex  $K_2[Cu(CN)_4]$  is  
 (a) Potassium tetracyanocuprate(II)  
 (b) Potassium tetracyanocuprate(I)  
 (c) Potassium tetracyanocopper(II)  
 (d) Potassium tetracyanocopper(I)  
 38. A square planar complex represented as:

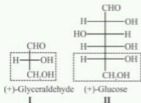


- (a) Optical isomerism (b) Linkage isomerism  
(c) Geometrical isomerism (d) None of these

39. Which of the following complexes formed by  $\text{Cu}^{2+}$  ions is most stable?

- (a)  $\text{Cu}^{2+} + 4\text{NH}_3 \rightleftharpoons [\text{Cu}(\text{NH}_3)_4]^{2+}$ ,  $\log K = 11.6$   
(b)  $\text{Cu}^{2+} + 4\text{CN}^- \rightleftharpoons [\text{Cu}(\text{CN})_4]^{2-}$ ,  $\log K = 27.3$   
(c)  $\text{Cu}^{2+} + 2\text{en} \rightleftharpoons [\text{Cu}(\text{en})_2]^{2+}$ ,  $\log K = 15.4$   
(d)  $\text{Cu}^{2+} + 4\text{H}_2\text{O} \rightleftharpoons [\text{Cu}(\text{H}_2\text{O})_4]^{2+}$ ,  $\log K = 8.9$

40. Assign the configuration to glyceraldehyde (I) and glucose (II).



Choose the correct option.

- (a) I  $\rightarrow$  D; II  $\rightarrow$  D (b) I  $\rightarrow$  L; II  $\rightarrow$  L  
(c) I  $\rightarrow$  L; II  $\rightarrow$  D (d) I  $\rightarrow$  D; II  $\rightarrow$  L
41. Glucose when heated with phenyl hydrazine forms  
(a) Fructosazone  
(b) Glucosazone  
(c) Glucose phenyl hydrazine  
(d) Phenyl hydrazine of glucosazone
42. Which of the following statement is not correct?  
(a) amino acid can exist as inner salt.  
(b) each polypeptide has one C-terminal and other N-terminal.  
(c) enzymes are naturally occurring simple proteins.  
(d) the union of two amino acids produces two peptide linkages.

43. Consider the following points

- (1) Cs is the strongest reducing agent in IA group element  
(2) Be does not form peroxide  
(3) The density of potassium is less than sodium  
(4) In alkali metals Li, Na, K and Rb, lithium has the minimum value of M.P.

Correct statements are

- (a) (1) & (2) are correct  
(b) (1), (2) & (3) are correct  
(c) (2) & (3) are correct

(d) (2), (3) & (4) are correct

44. On heating sodium metal in a current of dry ammonia gas the compound formed is

- (a) Sodium nitrate (b) Sodium hydride  
(c) Sodium amide (d) Sodium azide

45. White phosphorus reacts with chlorine and the product hydrolyses in the presence of water. The mass of HCl obtained by the hydrolysis of the product formed by the reaction of 62 g of white phosphorus with chlorine in the presence of water is

- (a) 0.219 g (b) 21.9g (c) 2.19g (d) 219g

## ANSWER KEY

- |       |       |       |       |       |
|-------|-------|-------|-------|-------|
| 1. c  | 2. d  | 3. d  | 4. d  | 5. c  |
| 6. b  | 7. d  | 8. b  | 9. d  | 10. b |
| 11. a | 12. d | 13. c | 14. d | 15. c |
| 16. d | 17. a | 18. d | 19. a | 20. c |
| 21. a | 22. d | 23. d | 24. b | 25. a |
| 26. b | 27. b | 28. d | 29. d | 30. c |
| 31. c | 32. d | 33. b | 34. a | 35. c |
| 36. b | 37. a | 38. d | 39. b | 40. a |
| 41. b | 42. d | 43. c | 44. c | 45. d |

## HINTS & SOLUTIONS

1.Sol: Isotones have same number of neutrons.

$${}^{76}_{32}\text{Ge}: n = 76 - 32 = 44$$

$$(i) {}^{77}_{32}\text{Ge}: n = 77 - 32 = 45$$

$$(ii) {}^{77}_{33}\text{As}: n = 77 - 33 = 44$$

$$(iii) {}^{77}_{34}\text{Se}: n = 77 - 34 = 43$$

$$(iv) {}^{78}_{34}\text{Se}: n = 78 - 34 = 44$$

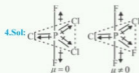
$$2.\text{Sol: } \lambda_A = \frac{h}{p_A} \text{ and } \lambda_B = \frac{h}{p_B}$$

$$\text{or } \frac{\lambda_A}{\lambda_B} = \frac{p_B}{p_A} = \frac{1}{2} \quad \left( \because p_B = \frac{1}{2} p_A \right)$$

$$\text{Given: } \lambda_A = 5 \times 10^{-8} \text{ m}$$

$$\therefore \frac{5 \times 10^{-8}}{\lambda_B} = \frac{1}{2} \Rightarrow \lambda_B = 10^{-7} \text{ m}$$

3.Sol: Hybridisation of Cl in  $\text{ClO}_4^-$  ion is  $sp^3$  and the ion has a tetrahedral structure.



5.Sol:  $F^-$  forms H-bond with HF, therefore, the species  $[H \cdots F - H]^+$  or  $HF_2^+$  exists.

6.Sol: Given  $T_1 = 300K$ ,  $T_2 = 273K$  (STP)

$$V_1 = 300ml,$$

$$P_1 = 730 \text{ mm of Hg}$$

$$P_2 = 760 \text{ mm of Hg}$$

$$V_2 = ?$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{730 \times 300}{300} = \frac{760 \times V_2}{273}$$

$$\therefore V_2 = 262.2 \text{ ml.}$$

7.Sol:  $\frac{r_1}{r_2} = \sqrt{\frac{T_1 \times M_2}{T_2 \times M_1}}$

8.Sol: If viscosity refers to resistance, then its inverse is ease of flow, i.e., fluidity.

10.Sol: pH of aqueous solution of an amphoteric salt is equal to the average of the  $pK_a$  of the salt and its conjugate acid.

11.Sol: Number of equivalents  $H_2SO_4$  taken

$$= \frac{0.2 \times 2 \times 400}{1000} = 0.16$$

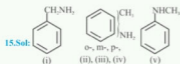
Number of equivalents KOH added

$$= \frac{600 \times 0.1}{1000} = 0.06$$

Number of equivalent of acid and bases neutralised each other = 0.06.

$$\therefore \text{Heat evolved} = 0.06 \times 57.1 \text{ kJ} = 3.426 \text{ kJ}$$

12.Sol:  $\Delta_f S^\circ \neq 0$  even for elementary substances.



16.Sol: Ethylpropionate is  $C_2H_5COOC_2H_5$ .

17.Sol: Volume of  $\frac{N}{10}$  HCl taken = 50 ml

Volume of  $\frac{N}{10}$  NaOH used for neutralisation of unused acid = 23.2 ml

$$\text{Now } N_1 V_1 (\text{NaOH}) = N_2 V_2 (\text{HCl})$$

$$23.2 \text{ ml of } \frac{N}{10} \text{ NaOH} = 23.2 \text{ ml of } \frac{N}{10} \text{ HCl}$$

$$\therefore \text{Volume of } \frac{N}{10} \text{ HCl unused} = 23.2 \text{ ml}$$

$\therefore$  Volume of  $N/10$  HCl required for neutralisation of  $NH_3 = 50 - 23.2 = 26.8 \text{ ml}$

$$26.8 \text{ ml of } \frac{N}{10} \text{ HCl} = 26.8 \text{ ml of } N/10 \text{ NH}_3$$

$\therefore$  Volume of  $N/10$  HCl required for neutralisation of  $NH_3 = 50 - 23.2 = 26.8 \text{ ml}$

$$26.8 \text{ ml of } \frac{N}{10} \text{ HCl} = 26.8 \text{ ml of } N/10 \text{ NH}_3$$

1000 ml of  $1N$   $NH_3$  solution contains

nitrogen = 14 g

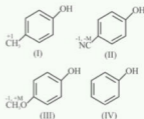
26.8 ml of  $NH_3$  solution contains nitrogen

$$= \frac{14 \times 26.8}{10 \times 1000}$$

Percentage of nitrogen

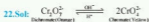
$$= \frac{14 \times 26.8 \times 100}{10 \times 1000 \times 0.257} = 14.6\%$$

18.Sol:

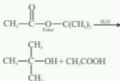


**20.Sol:**  $Ti^{4+}$  has no unpaired d electrons so colourless.

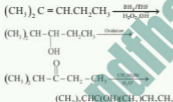
**21.Sol:** In the formation of metallic bonds, no electrons from 3d-orbitals are involved in case of zinc, while in all other metals of the 3d series, electrons from the d-orbitals are always involved in the formation of metallic bonds.



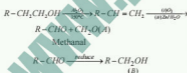
**23.Sol:**



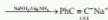
**24.Sol:**



**25.Sol:**



**26.Sol:** Malonic acid is  $\begin{matrix} COOH \\ \diagup \quad \diagdown \\ CH_2 \\ \diagdown \quad \diagup \\ COOH \end{matrix}$  is propane-1,3-dioic acid



**28.Sol:** Froth floatation method is used to concentrate sulphide ore which involves adsorption.

**29.Sol:** 400ml of gold sol require starch = 0.96 gm  
= 960 mg 10 ml of gold sol require starch

$$= \frac{960 \times 10}{400} = 24$$

We always calculate gold number for 10 ml of gold

**31.Sol:**  $E_{cell} = 0.77 - \frac{0.059}{1} \log \frac{1.5}{0.015} = 0.632V$

**33.Sol:** Two half lives = 1.386

**36.Sol:**  $P = P_A X_A + P_B X_B$

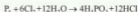
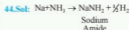
**38.Sol:** No isomerism given by the complex



**39.Sol:** Higher is the K value higher is the stability of complex

**40.Sol:** In (+) glucose, -OH on the lowest asymmetric carbon is on the right side which is comparable to (+) glyceraldehyde so it is assigned as D-configuration. The most oxidised carbon is at the top in the structure.

**42.Sol:** The union of two amino acids produces one peptide linkage.



1 mol of white phosphorus produces 12 mol of HCl  
62g of white phosphorus has been taken which is

$$\text{equivalent to } \frac{62}{124} = \frac{1}{2} \text{ mol.}$$

Therefore 6 mol HCl will be formed

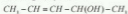
$$\text{Mass of 6 mol HCl} = 6 \times 36.5 = 219.0 \text{ g HCl.}$$

# CLASS XII

## CHEMISTRY KVPY(SX)-4 PREVIOUS YEAR QUESTIONS

### Alcohols, phenols and ethers

1. The number of stereoisomers possible for the following compound is [2017]

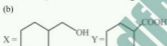
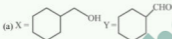


- (a) 1 (b) 2 (c) 3 (d) 4 [2017]

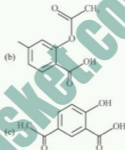
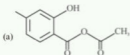
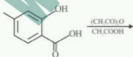
2. In the following reaction sequence [2017]



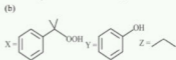
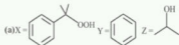
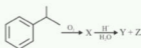
X and Y are, respectively



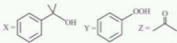
3. The major product in the following reaction is [2016]



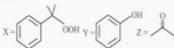
4. X, Y and Z in the following reaction sequence are [2016]



(c)



(d)



5. The major product of the reaction between

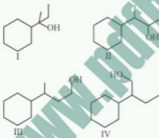
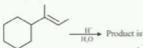
 $CH_3CH_2ONa$  and  $(CH_3)_3CCl$  in ethanol is

[2015]

- (a)  $CH_3CH_2OC(CH_3)_3$  (b)  $CH_2=C(CH_3)_2$   
 (c)  $CH_3CH_2C(CH_3)_3$  (d)  $CH_3CH=CHCH_3$

6. The major product of the reaction

[2015]



- (a) I (b) II (c) III (d) IV

7. An organic compound having molecular formula
- $C_2H_4O$
- undergoes oxidation to form X which contains 40% carbon, 6.7% hydrogen and 53.3% oxygen. The molecular formula of the compound X is

[2015]


- (a)  $CH_2O$  (b)  $C_2H_4O_2$   
 (c)  $C_2H_4O$  (d)  $C_2H_6O_2$


8. Major products formed in the reaction of t-butyl methyl ether with HI are

[2014]

- (a)
- $H_3C-I$
- and
- $\rightarrow OH$

- (b)
- 
- and
- $H_3C-OH$

- (c)
- $H_3C-OH$
- and
- 

- (d)
- 
- and
- $H_3C-OH$

9. The compound which reacts with excess bromine to produce 2, 4, 6-Tribromophenol is

[2013]

- (a) 1, 3-cyclohexadiene  
 (b) 1, 3-cyclohexanedione  
 (c) salicylic acid  
 (d) cyclohexanone



10. The major product of the following reaction is

[2012]



- (a)
- 

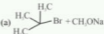
- (b)
- 

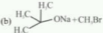
- (c)
- 
- (d)
- 

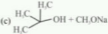
11. The reaction that gives the following molecule as the major product is

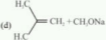
[2012]



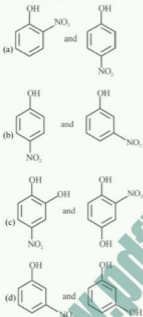
- (a)
- 

- (b)
- 

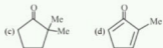
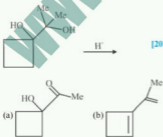
- (c)
- 

- (d)
- 

12. Phenol on treatment with dil.  $\text{HNO}_3$  gives two products P and Q. P is steam volatile but Q is not. P and Q are, respectively [2012]



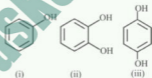
13. The major product of the following reaction is [2011]



14. The reaction of formation of  is known as [2011]

- (a) Perkin reaction  
(b) Sandmeyer reaction  
(c) Reimer-Tiemann reaction  
(d) Cannizzaro reaction

15. Among i-iii



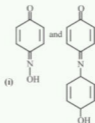
the boiling point follows the order [2011]

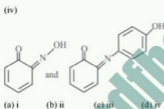
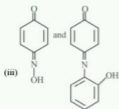
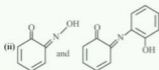
- (a) ii < i < iii  
(b) iii < ii < i  
(c) i < ii < iii  
(d) ii < iii < i

16. In the reaction sequence,

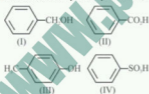


the major products X and Y, respectively, are [2011]



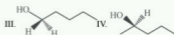
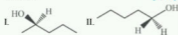


17. The order of acidity of compounds I-IV, is [2010]



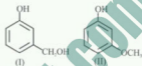
- (a) I < III < II < IV (b) IV < I < II < III  
 (c) III < I < II < IV (d) II < IV < III < I

18. The enantiomeric pair among the following four structures [2010]

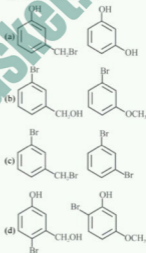


- (a) I & II (b) I & IV  
 (c) II & III (d) II & IV

19. Two isomeric compounds I and II are heated with HBr [2010]



The products obtained are



#### Aldehydes, ketones and carboxylic acids

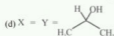
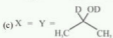
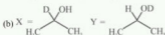
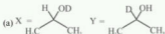
1. Upon reaction with  $\text{CH}_3\text{MgBr}$  followed by protonation, the compound that produces ethanol is [2017]

- (a)  $\text{CH}_3\text{CHO}$  (b)  $\text{HCOOH}$   
 (c)  $\text{HCHO}$  (d)  $(\text{CHO})_2$

2. In the following reactions [2017]



X and Y are



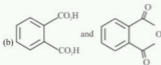
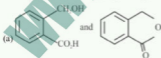
3. Upon heating with acidic  $\text{KMnO}_4$  an organic compound produces Hexane-1, 6-dioic acid as the major product the starting compound is [2016]

- (a) Benzene  
(b) Cyclohexene  
(c) 1-Methylcyclohexene  
(d) 2-Methylcyclohexene

4. In the reaction sequence [2016]



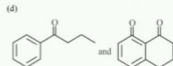
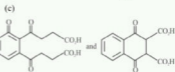
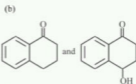
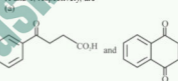
The major product X and Y, respectively, are



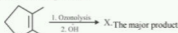
5. In the following reactions [2016]



X and Y, respectively, are



6. In the following reaction



X is

[2014]



7. 4-Formylbenzoic acid on treatment with one equivalent of hydrazine followed by heating with alcoholic KOH gives the major products [2014]

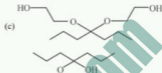
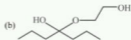


8. The density of acetic acid vapour at 300 K and

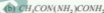
1 atm is  $5 \text{ mg cm}^{-3}$ . The number of acetic acid molecules in the cluster that is formed in the gas phase is closest to [2014]

(a) 5 (b) 2 (c) 3 (d) 4

9. Calcium butanoate on heating followed by treatment with 1,2-Ethanediol in the presence of catalytic amount of an acid, produces a major product which is: [2014]



10. Ethyl acetate reacts with  $\text{NH}_2\text{NHCONH}_2$  to form [2013]



11. The reaction of ethyl methyl ketone with  $\text{Cl}_2$  / excess  $\text{OH}^-$  gives the following major product [2013]



12. The compound that readily tautomerizes is [2013]







13. Aqueous solution of metallic nitrate X reacts with  $\text{NH}_4\text{OH}$  to form Y which dissolves in excess  $\text{NH}_4\text{OH}$ . The resulting complex is reduced by acetaldehyde to deposit the metal X and Y, respectively, are [2013]

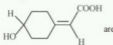
- (a)  $\text{Cs}(\text{NO}_3)_3$  and  $\text{CsOH}$   
 (b)  $\text{Zn}(\text{NO}_3)_2$  and  $\text{ZnO}$   
 (c)  $\text{AgNO}_3$  and  $\text{Ag}_2\text{O}$   
 (d)  $\text{Mg}(\text{NO}_3)_2$  and  $\text{Mg}(\text{OH})_2$

14. The major final product in the following reaction is [2012]



- (a)   
 (b)   
 (c)   
 (d) 

15. Two possible stereoisomers for [2011]







are

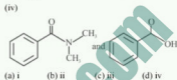
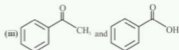
- (a) Enantiomers (b) Diastereomers  
 (c) Conformers (d) Rotamers

16. In the following conversion,



the major products X and Y, respectively, are [2011]

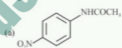
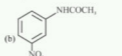
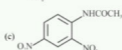
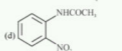
- (i)  and   
 (ii)  and 



### Amines

1. The major product formed in the following reaction is [2017]



- (a)   
 (b)   
 (c)   
 (d) 

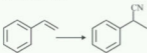
2. The reagent(s) used for the conversion of benzene diazonium hydrogensulfate to benzene is/are [2016]

- (a)  $\text{H}_2\text{O}$  (b)  $\text{H}_3\text{PO}_2 + \text{H}_2\text{O}$   
 (c)  $\text{H}_2\text{SO}_4 + \text{H}_2\text{O}$  (d)  $\text{CuCl} / \text{HCl}$

3. The compounds containing  $sp$  hybridized carbon atom are [2016]



4. The reagent required for the following two step transformation are [2016]



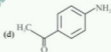
5. Reaction of aniline with  $NaNO_2 + dil.HCl$  at  $0^\circ C$  followed by reaction with  $CuCN$  yields [2015]



6. Aniline reacts with excess  $Br_2 / H_2O$  to give the major product [2014]



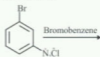
7. The major product obtained in the reaction of aniline with acetic anhydride is [2013]



8. The compound  $X(C_7H_9N)$  reacts with benzenesulfonyl chloride to give  $Y(C_{13}H_{13}NO_2S)$  which is insoluble in alkali. The compound X is [2013]



9. For the transformation [2011]



the reagent used is

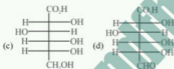
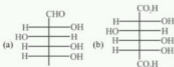
- (a)  $LiAlH_4$  (b)  $H_3PO_2$   
(c)  $H_2O^+$  (d)  $H_2 / Pt$

**Biomolecules**

1. Among the  $\alpha$ -amino acids-threonine, tyrosine, methionine, arginine and tryptophan, those which contain an aromatic group in their side chain are [2017]

- (a) Threonine and arginine  
(b) Tyrosine and tryptophan  
(c) Methionine and tyrosine  
(d) Arginine and tryptophan

2. The reaction of D-glucose with ammonical  $AgNO_3$  produces [2016]



3. The most abundant transition metal in human body is [2015]

- (a) Copper (b) Iron  
(c) Zinc (d) Manganese

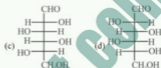
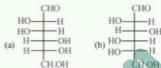
4. If  $\alpha$ -D-glucose is dissolved in water and kept for a few hours, the major constituent (s) present in the solution is (are)

- (a)  $\alpha$ -D-glucose  
(b) Mixture of  $\beta$ -D-glucose and open chain D-glucose  
(c) Open chain D-glucose  
(d) Mixture of  $\alpha$ -D-glucose and  $\beta$ -D-glucose

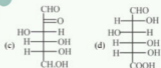
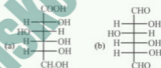
5. Given the structure of D-(+)-glucose as [2014]



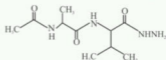
the structure of L-(-)-glucose is



6. D-Glucose upon treatment with bromine + water gives [2013]



7. The number of peptide bonds in the compound [2013]



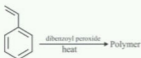
is (a) 1 (b) 2 (c) 3 (d) 4

8. In the DNA of E. Coli the mole ratio of adenine to cytosine is 0.7. If the number of moles of adenine in the DNA is 350000, the number of moles of guanine is equal to [2012]

- (a) 350000 (b) 500000  
(c) 225000 (d) 700000

## Polymers

1. The structure of the polymer obtained by the following reaction is [2015]



- (a) I (b) II (c) III (d) IV

2. Among i-iv



the compound that does not undergo polymerization under radical initiation is [2011]

- (a) i (b) ii (c) iii (d) iv

## Equilibrium

1. The reaction  $\text{C}_2\text{H}_4(\text{g}) \rightleftharpoons \text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g})$  is at equilibrium in a closed vessel at 1000 K. The enthalpy change ( $\Delta H$ ) for the reaction is 137 kJ mol<sup>-1</sup>. Which one of the following actions would shift the equilibrium to the right? [2017]  
 (a) Decreasing the volume of the closed reaction vessel  
 (b) Decreasing the temperature at which the reaction is performed  
 (c) Adding an inert gas to the closed reaction vessel  
 (d) Increasing the volume of the closed reaction vessel

2.  $\text{Mg}(\text{OH})_2$  is precipitated when NaOH is added to a solution of  $\text{Mg}^{2+}$ . If the final concentration of  $\text{Mg}^{2+}$  is  $10^{-10} \text{ M}$ , the concentration of  $\text{OH}^-(\text{M})$  in the solution is

[Solubility product for  $\text{Mg}(\text{OH})_2 = 5.6 \times 10^{-12}$ ]

[2017]

- (a) 0.056 (b) 0.12 (c) 0.24 (d) 0.025

3. The  $pK_a$  of oxoacids of chlorine in water follows the order [2016]

- (a)  $\text{HClO} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$   
 (b)  $\text{HClO}_4 < \text{HClO}_3 < \text{HClO}_2 < \text{HClO}$   
 (c)  $\text{HClO}_4 < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}$   
 (d)  $\text{HClO}_2 < \text{HClO} < \text{HClO}_3 < \text{HClO}_4$

4. The pH of 1N aqueous solutions of HCl,

$\text{CH}_3\text{COOH}$  and  $\text{HCOOH}$  follows the order

[2015]

- (a)  $\text{HCl} > \text{HCOOH} > \text{CH}_3\text{COOH}$   
 (b)  $\text{HCl} = \text{HCOOH} > \text{CH}_3\text{COOH}$   
 (c)  $\text{CH}_3\text{COOH} > \text{HCOOH} > \text{HCl}$   
 (d)  $\text{CH}_3\text{COOH} = \text{HCOOH} > \text{HCl}$

5. The equilibrium constants for the reaction

$\text{X} \rightleftharpoons 2\text{Y}$  and  $\text{Z} \rightleftharpoons \text{P} + \text{Q}$  are  $K_1$  and  $K_2$ ,

respectively. If the initial concentrations and the degree of dissociation of X and Z are the same, the ratio  $K_1/K_2$  is [2015]

- (a) 4 (b) 1 (c) 0.5 (d) 2

6. When 1.88 g of  $\text{AgBr}(\text{s})$  is added to a  $10^{-5} \text{ M}$

aqueous solution of KBr, the concentration of  $\text{Ag}^+$

is  $5 \times 10^{-6} \text{ M}$ . If the same amount of  $\text{AgBr}(\text{s})$  is

added to a  $10^{-2} \text{ M}$  aqueous solution of  $\text{AgNO}_3$ , the concentration of  $\text{Br}^-$  is [2014]

- (a)  $9.4 \times 10^{-6} \text{ M}$  (b)  $5 \times 10^{-10} \text{ M}$   
 (c)  $1 \times 10^{-11} \text{ M}$  (d)  $5 \times 10^{-11} \text{ M}$

7. The equilibrium constant  $K_c$  of the reaction,

$2\text{A} \rightleftharpoons \text{B} + \text{C}$  is 0.5 at  $25^\circ\text{C}$  and 1 atm. The

reaction will proceed in the backward direction when concentrations [A], [B] and [C] are, respectively [2014]

- (a)  $10^{-1}, 10^{-2}$  and  $10^{-2} \text{ M}$  (b)  $10^{-1}, 10^{-2}$  and  $10^{-2} \text{ M}$   
 (c)  $10^{-2}, 10^{-2}$  and  $10^{-3} \text{ M}$  (d)  $10^{-2}, 10^{-1}$  and  $10^{-3} \text{ M}$

8. The equilibrium constant ( $K_c$ ) of two reactions

$H_2 + I_2 \rightleftharpoons 2HI$  and  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  are 50 and 1000, respectively. The equilibrium constant of the reaction  $N_2 + 6HI \rightleftharpoons 2NH_3 + 3I_2$  is closest to:

[2014]

(a) 50000 (b) 20 (c) 0.008 (d) 0.005

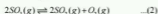
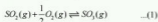
9. For the reaction,  $A \rightleftharpoons nB$  the concentration of A decreases from 0.06 to 0.03 mol L<sup>-1</sup> and that of B rises from 0 to 0.06 mol L<sup>-1</sup> at equilibrium. The values of n and the equilibrium constant for the reaction, respectively, are

[2013]

(a) 2 and 0.12 (b) 2 and 1.2

(c) 3 and 0.12 (d) 3 and 1.2

10. Consider the equilibria (1) and (2) with equilibrium constants  $K_1$  and  $K_2$ , respectively



$K_1$  and  $K_2$  are related as

[2013]

(a)  $2K_1 = K_2^2$  (b)  $K_1^2 = \frac{1}{K_2}$

(c)  $K_2^2 = \frac{1}{K_1}$  (d)  $K_2 = \frac{2}{K_1^2}$

11. The  $pK_a$  of a weak acid is 5.85. The concentrations of the acid and its conjugate base are equal at a pH of

[2012]

(a) 6.85 (b) 5.85 (c) 4.85 (d) 7.85

12. The equilibrium constant for the following reactions are  $K_1$  and  $K_2$ , respectively.



Then the equilibrium constant for the reaction



[2012]

(a)  $K_1 K_2$  (b)  $K_1 K_2^2$  (c)  $K_1^2 K_2^2$  (d)  $K_1^2 K_2$

13. From equations 1 and 2,

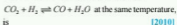


$$[K_c = 9.1 \times 10^{-13} \text{ at } 1000^\circ\text{C}] \text{ (eq. 1)}$$



$$[K_c = 7.1 \times 10^{-42} \text{ at } 1000^\circ\text{C}] \text{ (eq. 2)}$$

the equilibrium constant for the reaction



[2010]

(a) 0.78 (b) 2.0 (c) 16.2 (d) 1.28

14. The solubility product of  $Mg(OH)_2$  is  $1.0 \times 10^{-12}$ . Concentrated aqueous NaOH solution is added to a 0.01 M aqueous solution of  $MgCl_2$ . The pH at which precipitation occurs is

[2010]

(a) 7.2 (b) 7.8 (c) 8.0 (d) 9.0

### Some basic concepts of chemistry

1. Chlorine has two naturally occurring isotopes,  $^{35}\text{Cl}$  and  $^{37}\text{Cl}$ . If the atomic mass of Cl is 35.45, the ratio of natural abundance of  $^{35}\text{Cl}$  and  $^{37}\text{Cl}$  is closest to

[2017]

(a) 3.5 : 1 (b) 3 : 1 (c) 2.5 : 1 (d) 4 : 1

2. Three successive measurements in an experiment gave the values 10.9, 11.4042 and 11.42. The correct way of reporting the average value is

[2014]

(a) 11.2080 (b) 11.21

(c) 11.2 (d) 11

## ANSWER KEY

### Alcohols, phenols and ethers

1. d 2. a 3. b 4. d 5. b  
6. a 7. b 8. c 9. c 10. b  
11. b 12. a 13. c 14. c 15. c  
16. a 17. a 18. b 19. a

### Aldehydes, ketones and carboxylic acids

1. c 2. a 3. b 4. a 5. a  
6. a 7. b 8. b 9. a 10. c  
11. b 12. a 13. c 14. c 15. a  
16. c

### Amines

1. a 2. b 3. b 4. b 5. c  
6. a 7. a 8. a 9. b

### Biomolecules

1. b 2. c 3. b 4. d 5. b  
6. a 7. a 8. b

### Polymers

1. a 2. d

### Equilibrium

1. d 2. c 3. b 4. c 5. a  
6. d 7. a 8. c 9. a 10. b

11. b 12. b 13. d 14. d

Some basic concepts of chemistry

1. b 2. c

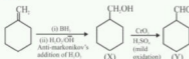
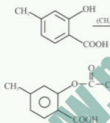
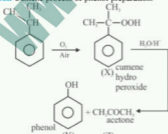
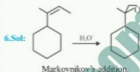
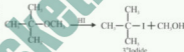
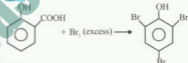
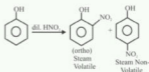
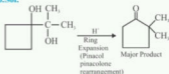
## HINTS &amp; SOLUTIONS

## Alcohols, phenols and ethers

**1.Sol:** Number of Geometrical isomers = 2 (one double bond)

Number of optical isomers = 2 (one chiral carbon)

Total number of stereoisomers = Number of Geometrical isomers + number of optical isomers = 2 + 2 = 4

**2.Sol:****3.Sol:** Anhydride reacts with alcohol part to form ester.**4.Sol:** Cumene process of phenol preparation.**5.Sol:** 3°RX undergoes elimination with base.**7.Sol:****8.Sol:****9.Sol:****10.Sol:****11.Sol:** Given reaction is an example of Williamson's synthesis reaction. To form 3° butyl ether alkyl halide must be primary and base must be 3°. If 3°RX is used, alkene is formed.**12.Sol:****13.Sol:**

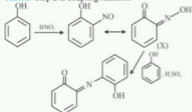
14.Sol: Reimer-Tiemann reaction gives salicylaldehyde

15.Sol: (iii) > (ii) > (i)

(iii) has intermolecular Hydrogen Bond

(ii) has intramolecular Hydrogen Bond

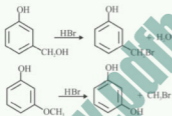
16.Sol: Step 2 is coupling reaction.



17.Sol: Sulphonic acid > carboxylic acid > Phenol > Alcohol (acidic nature)

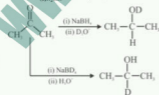
18.Sol: Structure I & IV have chiral carbons so can exist as enantiomers.

19.Sol:

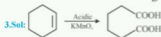


Aldehydes, ketones and carboxylic acids

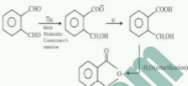
1.Sol:  $\text{HCHO} \xrightarrow[\text{conc. NaOH}]{\text{CaCl}_2/\text{aq. NaOH}} \text{CH}_3\text{CH}_2\text{OH}$



2.Sol:



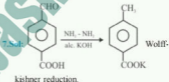
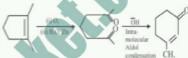
4.Sol:



5.Sol: Step 1: Electrophilic substitution reaction.

Step 2: Loss of water to form cyclic compound.

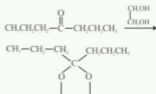
6.Sol:



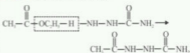
$$8.\text{Sol: } M = \frac{dRT}{P} = \frac{5 \times 0.0821 \times 300}{1} = 123.15$$

$$\text{No. of acetic acid molecules} = \frac{123.15}{60} = 2$$

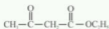
9.Sol:  $(\text{CH}_3\text{CH}_2\text{CH}_2\text{COO})_2\text{Ca} \xrightarrow{\Delta}$



10.Sol: Condensation Reaction



11.Sol:  $\alpha$ -methylation takes place.

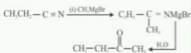


12.Sol:

Active Methylene Group

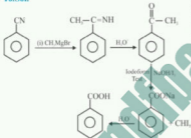
13.Sol: Tollen's test is for aldehydes.

14.Sol:

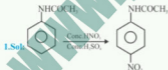


15.Sol: Due to chiral carbon, enantiomers are possible.

16.Sol:

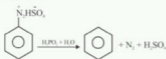


Amines

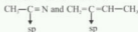


NHCOCCH<sub>3</sub> is O- and P-directing group

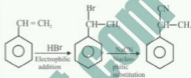
2.Sol: (reduction)



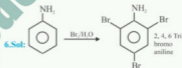
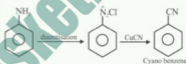
3.Sol: Carbon with a triple bond (or) two double bonds undergoes 'sp' hybridization.



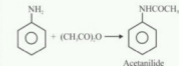
4.Sol:



5.Sol:

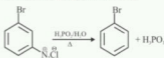


6.Sol:



8.Sol: 2° amine gives the given test.

9.Sol: H<sub>3</sub>PO<sub>2</sub> is the best reagent for diazonium salt to remove the group (diazonium salt)



Biomolecules

2.Sol: D-Gluconic Acid is formed.

3.Sol: Iron is present in Haemoglobin.

4.Sol: Mutarotation takes place.

5.Sol: Mirror image of D-glucose

6.Sol:  $D\text{-Glucose} \xrightarrow[\text{Water}]{\text{Inosine}}$   $D\text{-Gluconic Acid}$

7.Sol:  $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{NH} \end{array}$  bond is peptide bond.

8.Sol:  $\frac{A}{C} = 0.7$  now,  $\frac{350000}{C} = 0.7 \Rightarrow C = 500000$

### Polymers

1.Sol:



Polystyrene

2.Sol: Radical formed will not be stable on Carbon adjacent to Oxygen.

### Equilibrium

1.Sol: Decrease in volume favours more volumes side (more no. of moles side)

2.Sol:  $K_{sp} = [\text{Mg}^{2+}][\text{OH}^-]^2$

$$5.6 \times 10^{-12} = [10^{-20}][\text{OH}^-]^2$$

$$[\text{OH}^-] = \sqrt{\frac{5.6}{100}} = 0.24$$

3.Sol: Acidic strength increases with increase in oxidation number of central atom. Lower is pKa value, higher is acidic strength.

4.Sol: As  $\text{CH}_3\text{COOH}$  is weakest acid of all and HCl is strongest acid.

$$\frac{K_1}{K_2} = \frac{(2\alpha)^2}{1-\alpha} = \frac{4\alpha^2}{1-\alpha} = 4$$

6.Sol:  $K_{sp} = [\text{Ag}^+][\text{Br}^-]$

$$K_{sp} = 5 \times 10^{-30} \times 10^{-13} = 5 \times 10^{-43}$$

$$\text{Now, } K_{sp} = 5 \times 10^{-43} = 10^{-42} [\text{Br}^-]$$

$$[\text{Br}^-] = 5 \times 10^{-41}$$

7.Sol:  $Q = \frac{10^{-2} \times 10^{-2}}{(10^{-3})^2} = 100$

$K_c = 0.5$  as  $Q > K_c$ , reaction moves backward.

8.Sol:  $[\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}] \times 3, K_c = 50$

$$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 \quad K'_c = 1000$$

$$\text{N}_2 + 6\text{H}_2 \rightleftharpoons 2\text{NH}_3 + 3\text{I}_2 \quad K = ?$$

$$K = \frac{K'_c}{(K_c)^3} = \frac{1000}{(50)^3} = 0.008$$

9.Sol: A decreases from 0.06 to 0.03

B increases from 0 to 0.06

$$\Delta[A] = 0.03, \Delta[B] = 0.06$$

$$A \rightleftharpoons nB$$

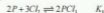
$$n = 2$$

10.Sol:  $K_2 = \frac{1}{K_1^2}$  (relation between  $1^{\text{st}}$  and  $2^{\text{nd}}$  equation is reversed and doubled)

$$11.\text{Sol: } \text{pH} = \text{pKa} + \log \frac{[\text{salt}]}{[\text{Acid}]}$$

$$\text{When } [\text{salt}] = [\text{acid}]$$

$$\text{pH} = \text{pKa}$$



$$12.\text{Sol: } \frac{2\text{P} + 5\text{Cl}_2 \rightleftharpoons 2\text{PCl}_5}{2\text{P} + 3\text{Cl}_2 \rightleftharpoons 2\text{PCl}_3} \quad K = K_1 K_2^2$$

13.Sol: Reversing equation 2 and adding to equation 1, we get the desired equation:

$$\text{Hence } K = K_1 \times \frac{1}{K_2} = \frac{K_1}{K_2} = \frac{9.1 \times 10^{-42}}{7.1 \times 10^{-42}} = \frac{9.1}{7.1} = 1.28$$

14.Sol:  $K_{sp} = [\text{Mg}^{2+}][\text{OH}^-]^2$

$$10^{-42} = (0.01)[\text{OH}^-]^2$$

$$\therefore [\text{OH}^-] = 10^{-20}$$

$$\text{So } p^{\text{OH}} = 5 \text{ and } p^{\text{H}} = 9$$

### Some basic concepts of chemistry

$$1.\text{Sol: } M_w = \frac{M_1 n_1 + M_2 n_2}{n_1 + n_2}$$

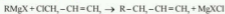
$$35.45 = \frac{35n_1 + 37n_2}{n_1 + n_2} \quad \text{or} \quad \frac{n_1}{n_2} = \frac{3}{1}$$

$$2.\text{Sol: } \frac{10.9 + 11.4042 + 11.42}{3} = 11.2$$



## Methods of preparation

### (1) Synthesis of Higher alkenes



### (2) From alkyne (Partial hydrogenation)



## IMPORTANT POINTS

### Stereospecific addition of hydrogen

- ❑ If Hydrogen is added on the same side of the triple bond it results cis isomer. This type of addition is referred as **SYN Addition**.
- ❑ If Hydrogen is added from opposite side of the triple bond it results trans isomer. This type of addition is referred as **anti Addition**.



### (3) From Alkyl halides

#### (1) By dehydrohalogenation

- ❑ Reaction of alkyl halide with alcoholic KOH or NaOH give alkenes. This is called as  $\beta$ -elimination.



- ❑ Reactivity order of alkyl halides



since the best leaving group order is  $\text{I}^- > \text{Br}^- > \text{Cl}^- > \text{F}^-$

- ❑ Various bases used for the dehydrohalogenation reactions are

I. Alkali metal hydroxides - NaOH, KOH

II. Alkali metal amides -  $\text{NaNH}_2$ ,  $\text{KNH}_2$

III. Alkali metal Alkoxides in alcohol -  $\text{CH}_3\text{ONa}$ ,  $\text{CH}_3\text{OK}/\text{CH}_3\text{OH}$   
 $\text{C}_2\text{H}_5\text{ONa}$ ,  $\text{C}_2\text{H}_5\text{OK}/\text{C}_2\text{H}_5\text{OH}$

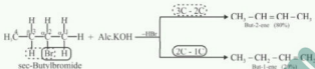
Sodium or Potassium isopropoxide / isopropyl alcohol

**Bulky base** - Sodium or Potassium t-butoxide/ t-butyl alcohol

IV. Trialkyl amines - Triethylamine (**Bulky base**)

- ❑ **Zaitsev's rule:** "Dehydrohalogenation of an alkyl halide results preferentially the production of more substituted alkene, i.e., more stable alkene." (or)  $\beta$ -Hydrogen is eliminated from the carbon having least number of hydrogen atoms to give more substituted alkene.

E.g: Dehydrohalogenation of sec-butyl bromide undergo in two way resulting two isomeric alkenes.



- **Exception to Zaitsev's rule:** When bulky bases are used less substituted alkene is produced referred as **HOFMANN PRODUCT**.

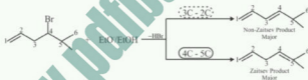
Bulky bases have steric hindrance. They find difficult to remove internal 2° hydrogen atom due to steric hindrance and hence prefer to remove more exposed 1° hydrogen atom than 2° hydrogen atom resulting in less substituted alkene. Such mechanism is said to be governed by HOFMANN Rule.

Irrespective of base (simple or Bulky)

*Alkyl flourides always produce more of Hofmann product.*



- If R-X already has a double bond in it then a product containing conjugated double bond is formed in preference to isolated double bonds. This is because conjugated double bonds result more stability.



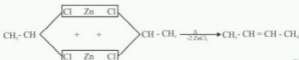
- If the Zaitsev's product is highly sterically crowded, less substituted alkene is formed as major product.



## (II) Dehalogenation of dihalides

Dihalides generally used for this method are geminal or vicinal.

- (A) Gem dihalides : When gem dihalide is heated with Zinc dust at 300°C then higher alkenes are formed. This reaction is based on free radical mechanism.



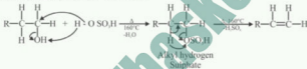
(B) Vicinal dihalides: When vicinal dihalides are heated with Zn dust, alkene with same no. of carbons as in parent is obtained.



(4) **From Alcohols**: When alcohol is heated with dehydrating agent alkenes are formed due to dehydration. Dehydrating agents = Conc.  $\text{H}_2\text{SO}_4$  at  $170^\circ\text{C}$ ,  $\text{POCl}_3/\text{Pyridine}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{H}_3\text{PO}_4$  at  $300^\circ\text{C}$ ,  $\text{KHSO}_4/\text{Al}_2\text{O}_3$  (Vap. state) at  $350^\circ\text{C}$ .

Order of reactivity of alcohol =  $3^\circ > 2^\circ > 1^\circ$  alcohol.

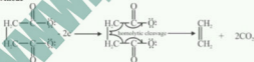
According to saytzeff's rule ( $\beta$ -elimination)



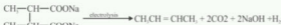
(5) **Kolbe's Synthesis**: Aqueous solution of Sodium or potassium salts of saturated dicarboxylic acid on electrolysis at high temperature produces alkene as major product.



At Anode



At Cathode



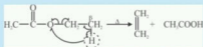
Sodium 2,3-Dimethylsuccinate

But-2-ene

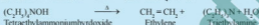


## Knowledge POOL

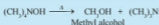
- ◆ **From ester (Pyrolysis of ester) :** When esters are heated in presence of liq.  $N_2$  and glass wool, then alkyl part of ester (containing beta hydrogen) converts into respective alkene while alkanoate part of ester is converted into respective acid.



- ◆ From pyrolysis of tetra alkyl ammonium hydroxide ( $R_4NOH$ ) :



- ◆ If methyl is the alkyl group methanol is formed along with trimethylamine.



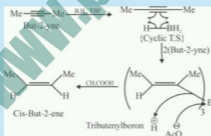
- ◆ **Cope reaction**



- ◆ **Hydroboration of Alkynes**

Non terminal Alkynes when treated with diborane in ether or THF give trialkenylboron. This on treatment with acetic acid gives cis alkenes. Mechanism involves cyclic transition state.

- ◆ **Exception:** If the trialkenyl boron is treated with  $H_2O_2$  /  $-OH$  we get aldehyde or ketone.



## Physical properties

- Alkenes having  $2C-4C$  are colourless, odourless gases,  $5C-17C$  are colourless liquids,  $18C$  onwards are solids.

- Practically insoluble in water because they can not form hydrogen bonds with  $H_2O$  molecules but they dissolve freely in organic solvents like benzene, chloroform,  $CCl_4$ , petroleum ether., etc.
- The boiling and melting points of alkenes are slightly higher than the corresponding alkanes because the intermolecular forces of attraction are stronger due to the presence of easily polarizable  $\pi$  - bond. Alkenes are therefore lesser volatile than the corresponding alkanes.
- Boiling points, Melting points and Specific gravities rise with the increase of molecular weight. The increase in branching in carbon chain decreases the boiling point among isomeric alkenes.

MP. and BP. a mol. wt.  $\propto \frac{1}{\text{branching in alkenes}}$

- B.P of Cis isomer is higher than Trans due to high polarity of Cis.  
M.P of Trans isomer is higher than Cis due to symmetrical packing of trans in crystal lattices.
- Alkenes are weakly polar. The polarity of cis isomer is more than trans which are either non polar or less polar (e.g. trans but-2-ene is non polar while trans pent-2-ene is weakly polar).

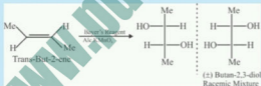
## Chemical properties

- Alkenes contain loosely bounded  $\pi$  electrons which can easily attract electrophiles hence undergo electrophilic addition reactions. Under special conditions alkenes undergo free radical substitution reactions.



### IMPORTANT POINTS

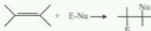
- **Stereoselective reactions:** The reactions in which the reactant may (or) may not exhibit stereoisomerism but the products of the reaction predominantly yield one of the stereoisomer are known as stereo selective reactions.
- **Stereospecific reaction:** The reaction in which both the reactants and products exhibit stereoisomerism and each reactant gives a specific stereoisomer as the product is known as stereospecific reaction.



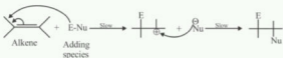
- All stereospecific reactions are stereoselective whereas the reverse is not true.

Alkene	Type of addition	Nature of product
Cis	Syn	Meso
Cis	Anti	Racemic mixture (CAR)
Trans	Syn	Racemic mixture
Trans	Anti	Meso (TAM)

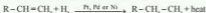
### (1) Electrophilic addition reactions



## Mechanism



## (I) Hydrogenation (Addition of hydrogen)



**Heat of hydrogenation:** The amount of heat liberated in the hydrogenation of one mole of alkene is known as heat of hydrogenation. Hydrogenation of alkenes is an exothermic process. Heat of hydrogenation decreases as the stability of alkene increases.

$$\text{Stability of alkene} \propto \frac{1}{\text{Heat of hydrogenation}}$$

The relative rates of hydrogenation :



**Heat of combustion:** When hydrogenation of alkene does not give the same alkane, the heat of combustion is used to measure their relative stabilities.



## IMPORTANT POINTS

**More -ve value of  $\Delta H_c^\circ$  less stable is the alkene or vice versa.**



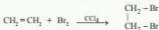
$\text{C}_4\text{H}_8$  has four isomers : Heat of combustion of these isomers are as follows.

- |                         |   |
|-------------------------|---|
| 1. But-1-ene :          | $\Delta H_c^\circ = -2720 \text{ kJ/mol}$ |
| 2. Cis-But-2-ene :      | $\Delta H_c^\circ = -2710 \text{ kJ/mol}$ |
| 3. Trans-But-2-ene :    | $\Delta H_c^\circ = -2705 \text{ kJ/mol}$ |
| 4. 2-Methylprop-1-ene : | $\Delta H_c^\circ = -2700 \text{ kJ/mol}$ |

Although all the isomers consume same amount of oxygen and liberate same amount of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  their heat of combustion values are different.

Based on this the stability order for above isomers is : **1 < 2 < 3 < 4**

(II) **Addition of halogens:** Alkene readily react with halogens in an inert solvent such as  $\text{CS}_2$ ,  $\text{CCl}_4$ , etc. giving vicinal dihalides at ordinary temperatures. Addition of halogens on alkene is trans addition



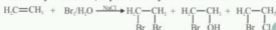
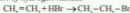
red brown

Ethylene dibromide (colourless)

Reactivity order of halogens is  $\text{Cl}_2 > \text{Br}_2 > \text{I}_2$

**Mechanism**

- Addition of halogens on alkenes is an example of electrophilic addition.
- It takes place through the formation of a carbonium ion.
- It is proved by the fact that when ethylene is treated with bromine water containing NaCl dissolved in it, we get a mixture of **ethylene bromide, ethylene bromohydrin and 1-Bromo-2-chloroethane**.

**(III) Addition of hydrogen halides**

Ethene                      ethyl bromide

Order of reactivity of HX:  $\text{HI} > \text{HBr} > \text{HCl} > \text{HF}$

Product formed by addition of HX to unsymmetrical alkenes ( $\text{R}-\text{CH}=\text{CH}_2$ ) takes place according to Markovnikov's rule.

**Markovnikov's rule:** The negative part of the addendum gets attached to that carbon atom which possess less number of Hydrogens atoms.

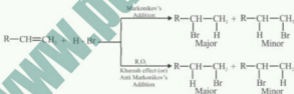
(or)

The electrophile adds to the  $\text{sp}^2$  carbon that is less substituted or contains more hydrogens.

**Anti-Markovnikov's rule or Peroxide effect or Kharash effect**

(Deviation from Markovnikov's rule - Possible only when HBr is used).

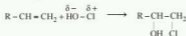
The ( $\text{H}^*$ ) add on to the  $\text{sp}^2$  carbon of unsymmetrical alkene which contains less number of Hydrogens.

**Mechanism**

**Markovnikov's addition:** Involves stable *carbocation* intermediate and is electrophilic addition.

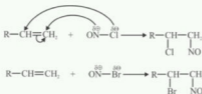
**Kharash Effect:** Involves stable Carbon free radical. Thus undergo Free radical mechanism.

In the presence of organic peroxides, addition of HBr takes place by a free radical mechanism as follows:

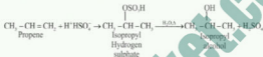
**(IV) Reaction with Hypohalous Acid**

alkylene chlorohydrin

**(V) Addition of Nitrosyl halide:** Nitrosyl bromide or Nitrosyl chloride (Tilden reagent) react according to Markowinkoff's rule to give alkene nitrosobromide and alkene nitrosochloride respectively.



(VI) *Addition of sulphuric acid* : Alkenes are absorbed by cold and conc.  $H_2SO_4$  giving alkyl hydrogen sulphate which further get hydrolysed to alcohols.



#### VID Hydration

Hydration of alkenes is carried out by following methods

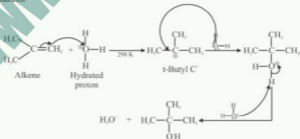
- (A) Acid catalysed reaction with water  
(B) Oxymercuration-Demercuration reaction.  
(C) Hydroboration oxidation reaction.  
(D) Reaction with R-X and Silver oxide in water give alkenols.

(A) Acid catalysed reaction

Addition of  $H_2O$  in presence of dilute acids like  $H_2SO_4$  or dil.  $H_3PO_4$  to alkene follows markovnikov's addition to give alcohols. Since the mechanism involves carbocation, the reaction proceed thru most stable carbocation involving rearrangement if condition demands.



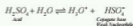
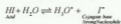
### Mechanism



○ Why dilute  $\text{H}_2\text{SO}_4$  or  $\text{H}_3\text{PO}_4$  is used instead of  $\text{HCl}$ ,  $\text{HBr}$  or  $\text{HI}$  and low temperatures is preferred?

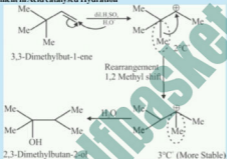
Low concentration of water and high temperatures promote dehydration of alcohol formed i.e., elimination reaction is encouraged.

Low Temperature and Dilute acids are preferred to keep concentration of water high so that  $C^+$  produced reacts with water. Conjugate bases of  $HCl$ ,  $HBr$   $HI$  are strong nucleophiles compared to conjugate bases of strong acids like  $H_2SO_4$  and  $H_3PO_4$ . Hence dilute strong acids are used.

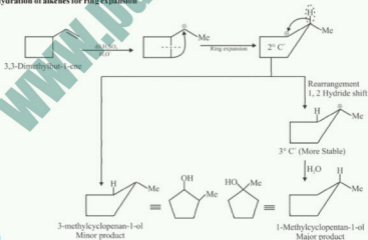


## Knowledge POOL

### ♦ Rearrangement in Acid catalysed Hydration

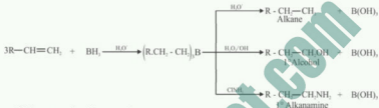


### Hydration of alkenes for ring expansion



## (B) Hydroboration

- Diborane readily reacts with alkene giving trialkyl boranes.
- Terminal olefins give primary alkyl borane.
- Terminal alkyl boranes are used to produce alkanes, alcohols and amines with different reagents.
- Oxidation with alkaline hydrogen peroxide gives primary alcohols.



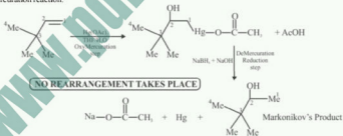
## (C) Oxymercuration - Demercuration

Alkenes react with mercuric acetate in THF and  $H_2O$  to produce hydroxyl alkyl mercury. This on reduction with  $NaBH_4$  in basic medium gives alcohols as per Markovnikov's rule.

### IMPORTANT POINTS

*No rearrangement takes place since  $C^+$  intermediate is not involved and the reaction is highly regioselective.*

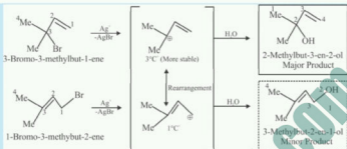
The reaction produces Hg in the final stage. The reaction is called oxymercuration reduction or oxymercuration-demercuration reaction.



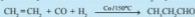
### Knowledge POOL

- ◆ **Reaction with R-X, Silver oxide and Water:** This is another method for preparation of alcohols from alkenes. Involves  $C^+$  hence rearrangement may take place to get stable  $C^+$ .





- ♦ **Hydroformylation:** Reaction with CO and  $\text{H}_2$  in presence of Cobalt catalyst at  $150^\circ\text{C}$



- ♦ **Alkylation (Addition of alkane):**

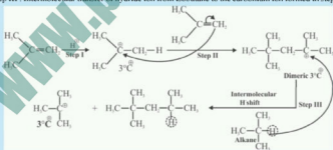


- ♦ **Mechanism of the reaction:**

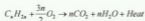
Step I: Formation of a carbonium ion from isobutene.

Step II: Addition of t-butyl carbonium ion to isobutene.

Step III: Intermolecular transfer of hydride ion from isobutane to the carbonium ion formed in step II.



(A) Combustion

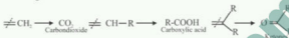


$$\frac{\text{Volume of alkene}}{\text{Volume of oxygen}} = \frac{2}{3n}; \text{ where } n \text{ is number of carbon atom}$$

(B) With acidic  $\text{KMnO}_4$  / Hot  $\text{KMnO}_4$  / acidic  $\text{K}_2\text{Cr}_2\text{O}_7$

Reaction of alkene with above reagents lead to cleavage of double bond.

Following are the transformation of double bond carbons.



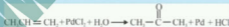
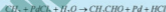
The above reactions are referred as oxidative cleavage of alkenes. This reaction can be used to identify the position of double bond in the given alkene. If double bond is present in ring it can also be identified.

E.g: Cyclobutene on oxidative cleavage with above reagents produce succinic acid. Dicarboxylic acid produced in the reaction indicates that the segment is either a ring or connected by two double bonds.



### IMPORTANT POINTS

#### Wacker reaction



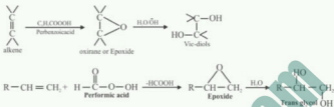
(C) Ozonolysis (Addition of ozone)

Ozonolysis of alkene is used as one of the criteria to identify the position of double bond in the alkene. This reaction is performed in two ways

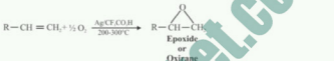
- Oxidative Ozonolysis
- Reductive Ozonolysis

(D) Epoxidation

(i) **Prileschaev Reaction/Reaction with Performic acid**: Alkenes react with peracids (per benzoic acid  $\text{C}_6\text{H}_5\text{COOOH}$ , per formic acid  $\sim 99\% \text{H}_2\text{O}_2 + \text{HCHO}$ ) to form oxiranes. (1, 2-epoxide), which on hydrolysis converted into dihydroxy compounds.



## ii) With Ag catalyst



(VIII) Hydroxylation : (Addition of (-OH) to alkenes): Are oxidised to 1,2 diols or glycols with following reagents.

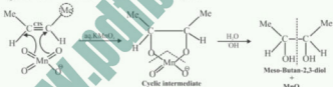
○ **Stereochemical aspects:** Hydroxylation of ALKENE by

(A) Syn addition: (Cis addition)

E.g: Osmium tetra oxide ( $\text{OsO}_4$ ) / Pyridine and  $\text{NaHSO}_4 + \text{H}_2\text{O}$  or  $\text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$

**Cold alkaline or aqueous  $\text{KMnO}_4$  (Baeyer's reagent)**

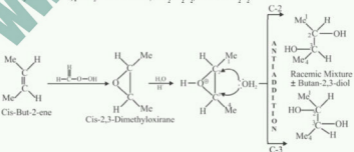
Used to test unsaturation where the pink colour of  $\text{KMnO}_4$  solution is discharged and a brown ppt of  $\text{MnO}_2$  is formed. Alkene is converted to 1,2 diols or Glycols

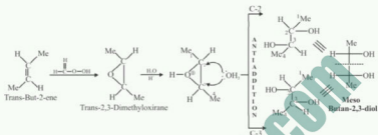


(B) Anti addition: (Trans addition) or Anti hydroxylation

E.g: Peroxyacid ( $\text{RCOOOH}$ ) followed by hydrolysis with  $\text{H}_2\text{O}$ .

Peroxybenzoic acid, peroxymethanoic acid,  $\text{SeO}_2 + \text{H}_2\text{O}_2$ ,  $\text{HCOOH} + \text{H}_2\text{O}_2$





(IX) **Substitution reaction** : Alkenes containing alkyl group with  $\alpha$ -hydrogen atoms undergo substitution reactions under suitable conditions.

(A) When treated with chlorine at high temperature (500–600°C), the  $\alpha$ -hydrogen atom of alkyl group is substituted by chlorine. Under these conditions  $\text{Cl}_2$  is not added across the double bond but displace  $\alpha$ -hydrogen atom.

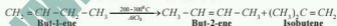
Propene gives allyl chloride on reaction with chlorine at high temperature.



(B) NBS-N-Bromosuccinimide is used to replace  $\alpha$ -hydrogen atom (allylic hydrogens) with Bromine without disturbing double bond.

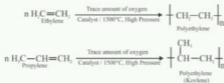


(X) **Isomerisation** : Alkenes isomerise when heated at high temperature (500 – 700°C) or at lower temperatures (200–300°C) in the presence of anhyd.  $\text{AlCl}_3$  or  $\text{Al}_2(\text{SO}_4)_3/\text{H}_2\text{SO}_4$



(XI) **Polymerisation** : The process in which many simple molecules combine together to form a large single molecule without elimination of anything is known as addition polymerisation. The simple molecule is called a monomer and the single large molecule is called a polymer.

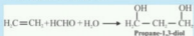
Polymerisation is a reversible process.



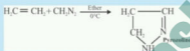
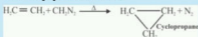


Some special chemical reaction of ethylene ( $C_2H_4$ )

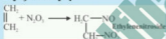
♦ **With HCHO (formaldehyde)**



♦ **With  $CH_2N_2$  (diazomethane)**



♦ **With  $N_2O_3$  and  $N_2O_4$**

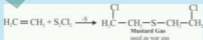


♦ Ethylene add on to acid chlorides, alkyl chlorides and  $\alpha$ -halogenated ethers in the presence of aluminium chloride

E.g:



♦ **With sulphur monochloride ( $S_2Cl_2$ )**



## MOCK TEST PAPER

JEE MAIN - 2

2018

2019

- In the general electronic configuration  $(n-2)f^{1-14}(n-1)d^{1-10}ns^2$ , if value of  $n = 7$  the configuration will be  
(a) Lanthanides (b) Actinides  
(c) Transition elements (d) Noble gases
- Which is correct in the following?  
(a) Radius of Cl atoms is  $0.99 \text{ \AA}$ , while that of  $Cl^+$  ion is  $1.54 \text{ \AA}$   
(b) Radius of Cl atoms is  $0.99 \text{ \AA}$ , while that of Na atom is  $1.54 \text{ \AA}$   
(c) Radius of Cl atoms is  $0.95 \text{ \AA}$ , while that of  $Cl^+$  ion is  $0.81 \text{ \AA}$   
(d) Radius of Na atoms is  $0.95 \text{ \AA}$ , while that of  $Na^+$  ion is  $1.54 \text{ \AA}$
- When Lithium vapour is taken in a discharge tube and the potential difference between the electrodes is  $5.4 \text{ eV}$ , there is a sudden increase in the flow of current. The I.E. of Lithium per mole is  
(a)  $54 \text{ eV}$  (b)  $520 \text{ kJ mol}^{-1}$   
(c)  $54 \text{ kJ atom}^{-1}$  (d)  $5.4 \text{ eV atom}^{-1}$
- The variation of dipole moment ( $\mu$ ) and angle ( $\theta$ ) change with a change in hybridisation from  $sp^3 \rightarrow sp^2 \rightarrow sp$  is  
(a)  $\mu$  increases,  $\theta$  decreases  
(b)  $\mu$  decreases,  $\theta$  increases  
(c)  $\mu$  and  $\theta$  both decrease  
(d)  $\mu$  and  $\theta$  both increase
- The dipole moment of  $o$ -,  $p$ - and  $m$ -dichlorobenzene will be in the order  
(a)  $o > p > m$  (b)  $p > o > m$   
(c)  $m > o > p$  (d)  $o > m > p$
- The mol. wt. of an Oxide of Hydrogen is 34. Therefore the number of covalent bonds in its molecule are  
(a) 4 (b) 5 (c) 2 (d) 3
- A truck carrying oxygen cylinders is filled with oxygen at  $-22^\circ\text{C}$  and at pressure of 3 atmosphere in Srinagar, Kashmir. Determine the internal pressure when the truck drives through Madras, Tamilnadu where the temperature is  $30^\circ\text{C}$   
(a)  $2.64 \text{ atm}$  (b)  $1.64 \text{ atm}$   
(c)  $1 \text{ atm}$  (d)  $3.64 \text{ atm}$
- A gas is heated in such a way so that its pressure and volume both become double. Again by lowering temperature, one fourth of initial number of moles of air has been taken in, to maintain the double volume and pressure. By what fraction, the temperature must have been raised finally?  
(a)  $1/5$  (b)  $4/5$  (c)  $16/5$  (d)  $8/5$
- Specify if addition of the second substance in each of the following increases (I) or decreases (D), the solubility of the first substance.  
(i)  $Al(OH)_3$ ,  $NaOH$  (ii)  $PbCl_2$ ,  $Pb(NO_3)_2$   
(iii)  $CuSO_4$ ,  $NH_3$   
(a) 1-D, 2-I, 3-I (b) 1-I, 2-D, 3-I  
(c) 1-I, 2-D, 3-I (d) 1-D, 2-D, 3-I
- For a first order reaction  $A \rightarrow B$  the reaction rate at which reactant concentration of  $0.01 \text{ M}$  is found to be  $2.0 \times 10^{-4} \text{ M sec}^{-1}$ . The half-life period of the reaction is :  
(a) 30 s (b) 300 s (c) 220 s (d) 347 s.
- For which of the following reactions, the temperature coefficient is maximum?  
(a)  $A \rightarrow B$ ;  $E_a = 50 \text{ kJ}$  (b)  $P \rightarrow Q$ ;  $E_a = 40 \text{ kJ}$   
(c)  $X \rightarrow Y$ ;  $E_a = 60 \text{ kJ}$  (d)  $W \rightarrow Z$ ;  $E_a = 80 \text{ kJ}$

12. The enthalpy change for the process  $\text{CCl}_{4(g)} \rightarrow \text{C}_{(s)} + 4\text{Cl}_{(g)}$  and bond enthalpy of C-Cl in  $\text{CCl}_4(\text{g})$  is

Given,  $\Delta_{\text{vap}} H^\circ(\text{CCl}_4) = 30.5 \text{ kJ mol}^{-1}$ .

$$\Delta_f H^\circ(\text{CCl}_4) = -135.5 \text{ kJ mol}^{-1}$$

$\Delta_a H^\circ(\text{C}) = 715.0 \text{ kJ mol}^{-1}$ , where  $\Delta_a H^\circ$  is enthalpy of atomisation

$$\Delta_a H^\circ(\text{Cl}_2) = 242 \text{ kJ mol}^{-1}$$

- (a)  $1304 \text{ kJ mol}^{-1}$ ,  $652 \text{ kJ mol}^{-1}$   
 (b)  $1304 \text{ kJ mol}^{-1}$ ,  $326 \text{ kJ mol}^{-1}$   
 (c)  $652 \text{ kJ mol}^{-1}$ ,  $1304 \text{ kJ mol}^{-1}$   
 (d)  $326 \text{ kJ mol}^{-1}$ ,  $1304 \text{ kJ mol}^{-1}$
13.  $\text{H}_2\text{S}$  gas is used in qualitative analysis of inorganic cations. Its solubility in water at STP is  $0.195 \text{ mol kg}^{-1}$ . Thus, Henry's law constant (in  $\text{atm mol}^{-1}$ ) for  $\text{H}_2\text{S}$  is:

- (a)  $2.628 \times 10^{-4}$  (b)  $5.128$   
 (c)  $0.185$  (d)  $3.826 \times 10^1$

14. A solution is obtained by mixing 300g of 25% solution and 400g of 40% solution by mass. The mass percentage of the resulting solution is:  
 (a) 66.66% (b) 3.36%  
 (c) 33.6% (d) 22.4%

15. In the button cell widely used in watches and other devices the following reaction takes place:



Determine  $\Delta_r G^\circ$  for the reaction.

(Given  $E^\circ_{\text{cell}} = 1.1 \text{ V}$ )

- (a)  $-2.14 \times 10^4 \text{ J}$  (b)  $-2.14 \times 10^4 \text{ kJ}$   
 (c)  $-214 \text{ kJ}$  (d)  $-214 \text{ J}$

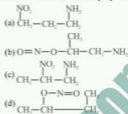
16. Which of the following is crotonic acid?

- (a)  $\text{CH}_2 = \text{CH} - \text{COOH}$   
 (b)  $\text{C}_6\text{H}_5 - \text{CH} = \text{CH} - \text{COOH}$   
 (c)  $\text{CH}_3 - \text{CH} = \text{CH} - \text{COOH}$   
 (d)  $\begin{array}{c} \text{CH} - \text{COOH} \\ || \\ \text{CH} - \text{COOH} \end{array}$

17. Trivial name of 2, 3- dihydroxy butanedioic acid is

- (a) Malic acid (b) Tartaric acid  
 (c) Citric acid (d) Lactic acid

18. The structure of 2-Nitro-1-propanamine is



19. I.U.P.A.C. name of



- (a) Methyl-2,2- acetyl ethanoate  
 (b) 2,2- Acetyl-1-methoxy ethanone  
 (c) Methyl-2-acetyl-3-oxobutanoate  
 (d) None

20. The correct IUPAC name of the following compound is



- (a) 4-tert-Butyl-3-chloro heptane  
 (b) 3-Chloro-4-tert-butyl heptane  
 (c) 2,2-Dimethyl-4-chloro-3-ethyl hexane  
 (d) 4-Chloro-3-ethyl-2,2-dimethyl hexane

21. What amount of bromine will be required to convert 2g of phenol into 2,4,6-tribromophenol?

- (a) 10.22 (b) 20.44 (c) 4.00 (d) 6.00

22. IUPAC name of the following compound is



- (a) 3-Oxocyclohexanecarbaldehyde  
 (b) 3-Carboxycyclohexanal  
 (c) 3-Carboxycyclohexanone  
 (d) None of these

23. A and B are two salts. A with dil. HCl and A & B with conc.  $\text{H}_2\text{SO}_4$  react to give reddish brown vapours, hence A & B respectively are :

- (a)  $\text{NaNO}_3$ ,  $\text{NaBr}$  (b)  $\text{NaBr}$ ,  $\text{NaNO}_3$

- (c) NaBr, NaNO<sub>2</sub> (d) NaNO<sub>2</sub>, NaBr
24. If NaOH is added to an aqueous solution of Zn<sup>2+</sup> ions, a white precipitate appears and on adding excess NaOH, the precipitate dissolves. In this solution zinc exists in the:
- (a) Cationic part  
(b) Anionic part  
(c) Both in cationic and anionic parts  
(d) There is no zinc left in the solution
25. Acidified potassium dichromate oxidises
- I. Iodides to iodine  
II. Sulphides to sulphur  
III. Tin (IV) to tin (II)  
IV. Iron (III) salts to iron (II) salts
- The appropriate option with correct choices are
- (a) I, II and III (b) II, III and IV  
(c) I and IV (d) I and II
26. Permanent magnets are generally made of alloys of
- (a) Zn (b) Pb (c) Al (d) Co
27. The complex compound in which metal is not present in zero oxidation state?
- (a) [Ni(CO)<sub>4</sub>] (b) K[PtCl<sub>3</sub>(C<sub>2</sub>H<sub>4</sub>)]  
(c) Mn<sub>2</sub>(CO)<sub>10</sub> (d) [Cr(C<sub>6</sub>H<sub>6</sub>)<sub>2</sub>]
28. Which gas will be adsorbed on a solid to greater extent?
- (a) A gas having non polar molecule  
(b) A gas having the highest critical temperature (T<sub>c</sub>)  
(c) A gas having the lowest critical temperature  
(d) A gas having the highest critical pressure
29. The two forms of D-glucopyranose obtained from the solution of D-glucose are called
- (a) Isomer (b) Anomer  
(c) Epimer (d) Enantiomer
30. A mixture contains three amino acids A (pH = 3.2), B (pH = 5.7) and C (pH = 9.7). When it is subjected to electrophoresis at pH 7.7, in which direction will each component of the mixture move?
- (a) A to anode, B and C to cathode  
(b) A to cathode, B no movement, C to anode  
(c) A to anode, B no movement, C to anode  
(d) A and B to anode and C to cathode

## ANSWER KEY

- 1.b 2.b 3.b 4.b 5.d  
6.d 7.d 8.c 9.c 10.d

- 11.d 12.b 13.b 14.c 15.c  
16.c 17.b 18.c 19.c 20.a  
21.a 22.a 23.d 24.c 25.d  
26.d 27.a 28.b 29.b 30.d

## HINTS &amp; SOLUTIONS

2.Sol: The atomic radius decreases along the period. Also cations are always smaller than their parent atoms and anions are always larger than their parent atom.

3.Sol:  $IE = 5.4 \text{ eV} (1 \text{ eV} = 96.54 \text{ kJ/mol})$

4.Sol:  $sp^3 (109^\circ 28') \rightarrow sp^2 (120^\circ) \rightarrow sp (180^\circ)$ . The magnitude of angle is increasing and hence dipole moment will go on decreasing.

5.Sol: Bond angle is inversely proportional to the dipole moment

6.Sol:  $H_2O_2$  has 3 covalent bond.

7.Sol:  $P_1 = 3 \text{ atm}, P_2 = ?$

$$T_1 = -23 + 273 = 250 \text{ K}$$

$$T_2 = 273 + 30 = 303 \text{ K}$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{3}{250} = \frac{P_2}{303}$$

$$P_2 = \frac{3 \times 303}{250} = 3.64 \text{ atm}$$

$$8.\text{Sol: } \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{P_1 V_1}{T_1} = \frac{2P_1 \times 2V_1}{T_2} \Rightarrow T_2 = 4T_1$$

When air has been taken in and P, V remain constant,  $n_1 \cdot 4T_1 = n_2 \cdot T_2$   
Initial no. of moles = n

$$n_1 = n \text{ and } n_2 = n + \frac{1}{4}n = \frac{5}{4}n$$

$$\text{Total} = n_1 + \frac{n_2}{4} = \frac{5}{4}n$$

$$\therefore n \cdot 4T_1 = \frac{5}{4}n \cdot T_2 \Rightarrow T_2 = \frac{16}{5}T_1$$

9.Sol: (i) Adding NaOH increases solubility of  $Al(OH)_3$  by forming complex  $Na[Al(OH)_4]$



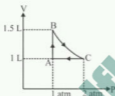
# CLASS XII

# CHEMISTRY KVPY(SX)-5

## PREVIOUS YEAR QUESTIONS

### Thermodynamics

1. A system consisting of 1 mol of an ideal gas undergoes a reversible process,  $A \rightarrow B \rightarrow C \rightarrow A$  (schematically indicated in the figure below). If the temperature at the starting point A is 300 K and the work done in the process  $B \rightarrow C$  is 1 L atm, the heat exchanged in the entire process in L atm is [2017]



- (a) 1.0 (b) 0.0 (c) 1.5 (d) 0.5
2. For the reaction  $N_2 + 3X_2 \rightarrow 2NX_3$ , where  $X = F, Cl$ , (the average bond energies are  $F-F = 155 \text{ kJ mol}^{-1}$ ,  $N-F = 272 \text{ kJ mol}^{-1}$ ,  $Cl-Cl = 242 \text{ kJ mol}^{-1}$ ,  $N-Cl = 200 \text{ kJ mol}^{-1}$  and  $N \equiv N = 941 \text{ kJ mol}^{-1}$ ), the heats of formation of  $NF_3$  and  $NCI_3$  in  $\text{kJ mol}^{-1}$  respectively, are closest to [2015]
- (a) -226 and +467 (b) +226 and -467  
(c) -151 and +311 (d) +151 and -311
3. The latent heat of melting of ice at  $0^\circ\text{C}$  is  $6 \text{ kJ mol}^{-1}$ . The entropy change during the melting in  $\text{JK}^{-1} \text{mol}^{-1}$  is closest to [2014]
- (a) 22 (b) 11 (c) -11 (d) -22
4. The molar enthalpy change for  $H_2O(l) \rightleftharpoons H_2O(g)$  at 373 K and 1 atm is  $41 \text{ kJ/mol}$ . Assuming ideal behaviour, the internal energy change for vaporization of 1 mol of water at 373 K and 1 atm in  $\text{kJ mol}^{-1}$  is: [2014]
- (a) 30.2 (b) 41.0 (c) 48.1 (d) 37.9

5. Given that the bond energies of:  $N \equiv N$  is  $946 \text{ kJ mol}^{-1}$ ,  $H-H$  is  $435 \text{ kJ mol}^{-1}$ ,  $N-N$  is  $159 \text{ kJ mol}^{-1}$ , and  $N-H$  is  $389 \text{ kJ mol}^{-1}$ , the heat of formation of hydrazine in the gas phase in  $\text{kJ mol}^{-1}$  is: [2014]
- (a) 833 (b) 101 (c) 334 (d) 1268
6. The entropy change in the isothermal reversible expansion of 2 moles of an ideal gas from 10 to 100 L at 300 K is [2013]
- (a)  $42.3 \text{ JK}^{-1}$  (b)  $35.8 \text{ JK}^{-1}$   
(c)  $38.3 \text{ JK}^{-1}$  (d)  $32.3 \text{ JK}^{-1}$
7. For the isothermal reversible expansion of an ideal gas [2013]
- (a)  $\Delta H > 0$  and  $\Delta U = 0$   
(b)  $\Delta H > 0$  and  $\Delta U < 0$   
(c)  $\Delta H = 0$  and  $\Delta U = 0$   
(d)  $\Delta H = 0$  and  $\Delta U > 0$
8. Typical electronic energy gaps in molecules are about 1.0 eV. In terms of temperature, the gap is close to [2012]
- (a)  $10^3 \text{ K}$  (b)  $10^4 \text{ K}$  (c)  $10^5 \text{ K}$  (d)  $10^6 \text{ K}$
9. The  $\Delta H$  for vaporization of a liquid is  $20 \text{ kJ/mol}$ . Assuming ideal behaviour, the change in internal energy for the vaporization of 1 mol of the liquid at  $60^\circ\text{C}$  and 1 bar is close to [2012]
- (a)  $13.2 \text{ kJ/mol}$  (b)  $17.2 \text{ kJ/mol}$   
(c)  $19.5 \text{ kJ/mol}$  (d)  $20.0 \text{ kJ/mol}$
10. Three moles of an ideal gas expands reversibly under isothermal condition from 2 L to 20 L at 300 K. The amount of heat-change (in  $\text{kJ/mol}$ ) in the process is [2012]
- (a) 0 (b) 7.2 (c) 10.2 (d) 17.2
11. For a process to occur spontaneously [2011]
- (a) only the entropy of the system must increase  
(b) only the entropy of the surroundings must increase  
(c) either the entropy of the system or that of the surroundings must increase  
(d) the total entropy of the system and the surroundings must increase

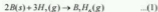
12. A concentrated solution of copper sulphate, which is dark blue in colour, mixed at room temperature with a dilute solution of copper sulphate, which is light blue. For this process [2010]

(a) Entropy change is positive, but enthalpy change is negative  
(b) Entropy and enthalpy changes are both positive  
(c) Entropy change is positive and enthalpy does not change  
(d) Entropy change is negative and enthalpy does not change

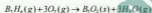
13. For the reaction  $A \rightarrow B$ ,  $\Delta H^\circ = 7.5 \text{ kJ mol}^{-1}$ . The value of  $\Delta G^\circ$  and the temperature at which the reaction reaches equilibrium are, respectively, [2010]

(a) 0 kJ mol<sup>-1</sup> and 400 K  
(b) -2.5 kJ mol<sup>-1</sup> and 400 K  
(c) 2.5 kJ mol<sup>-1</sup> and 200 K  
(d) 0 kJ mol<sup>-1</sup> and 300 K

14. Diborane is formed from the elements as shown in equation (1)



Given that



$$\Delta H_f^\circ = -2035 \text{ kJ}$$



the  $\Delta H^\circ$  for the reaction (1) is [2010]

(a) 36 kJ (b) 509 kJ  
(c) 520 kJ (d) -3550 kJ

#### Structure of Atom

1. For a 4p orbital, the number of radial and angular nodes, respectively, are [2017]

(a) 3, 2 (b) 1, 2 (c) 2, 4 (d) 2, 1

2. The electronic configuration of an element with the largest difference between the 1<sup>st</sup> and 2<sup>nd</sup> ionization energies is [2015]

(a)  $1s^2 2s^2 2p^6$  (b)  $1s^2 2s^2 2p^6 3s^1$   
(c)  $1s^2 2s^2 2p^6 3s^2$  (d)  $1s^2 2s^2 2p^1$

3. For a one-electron atom, the set of allowed quantum numbers is [2012]

(a)  $n = 1, l = 0, m_l = 0, m_s = +\frac{1}{2}$

(b)  $n = 1, l = 1, m_l = 0, m_s = +\frac{1}{2}$

(c)  $n = 1, l = 0, m_l = -1, m_s = -\frac{1}{2}$

(d)  $n = 1, l = 1, m_l = 1, m_s = -\frac{1}{2}$

4. The isoelectronic pair of ions is [2012]

(a)  $Sc^{2+}$  and  $V^{3+}$  (b)  $Mn^{2+}$  and  $Fe^{2+}$

(c)  $Mn^{3+}$  and  $Fe^{2+}$  (d)  $Ni^{3+}$  and  $Fe^{2+}$

5. A metal is irradiated with light of wavelength 660 nm. Given that the work function of the metal is 1.0 eV, the deBroglie wavelength of the ejected electron is close to [2012]

(a)  $6.6 \times 10^{-2} \text{ m}$  (b)  $8.9 \times 10^{-11} \text{ m}$

(c)  $1.3 \times 10^{-9} \text{ m}$  (d)  $6.6 \times 10^{-13} \text{ m}$

6. The electron in hydrogen atom is in the first Bohr orbit ( $n = 1$ ). The ratio of transition energies,  $E(n = 1 \rightarrow n = 3)$  to  $E(n = 1 \rightarrow n = 2)$ , is [2011]

(a)  $\frac{32}{27}$  (b)  $\frac{16}{27}$  (c)  $\frac{32}{9}$  (d)  $\frac{8}{9}$

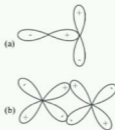
7. The energy of a photon of wavelength  $\lambda = 1$  meter is (Planck's constant  $= 6.625 \times 10^{-34} \text{ J s}$ , speed of light  $= 3 \times 10^8 \text{ m/s}$ ) [2010]

(a)  $1.988 \times 10^{-21} \text{ J}$  (b)  $1.988 \times 10^{-28} \text{ J}$

(c)  $1.988 \times 10^{-36} \text{ J}$  (d)  $1.988 \times 10^{-25} \text{ J}$

#### Chemical bonding

1. Among the following atomic orbital overlaps, the non-bonding overlap is [2016]



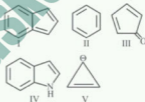


2. The molecule with the highest dipole moment among the following is [2016]  
 (a)  $NH_3$  (b)  $F_2$  (c)  $CO$  (d)  $HF$
3. The most stable Lewis acid-base adduct among the following is [2016]  
 (a)  $H_2O \rightarrow BCl_3$  (b)  $H_2S \rightarrow BCl_3$   
 (c)  $H_3N \rightarrow BCl_3$  (d)  $H_3P \rightarrow BCl_3$
4. The Lewis acid strength of  $BBr_3$ ,  $BCl_3$  and  $BF_3$  is in the order [2015]  
 (a)  $BBr_3 > BCl_3 > BF_3$  (b)  $BCl_3 < BF_3 < BBr_3$   
 (c)  $BF_3 < BBr_3 < BCl_3$  (d)  $BBr_3 < BF_3 < BCl_3$
5.  $O^{2-}$  is isoelectronic with [2015]  
 (a)  $Zn^{2+}$  (b)  $Mg^{2+}$  (c)  $K^+$  (d)  $Ni^{2+}$
6. The  $H-C-H$ ,  $H-N-H$ , and  $H-O-H$  bond angles (in degrees) in methane, ammonia and water are respectively, closest to [2015]  
 (a) 109.5, 104.5, 107.1 (b) 109.5, 107.1, 104.1  
 (c) 104.5, 107.1, 109.5 (d) 107.1, 104.5, 109.5
7. The order of electronegativity of carbon in  $sp$ ,  $sp^2$  and  $sp^3$  hybridized states follows [2015]  
 (a)  $sp > sp^2 > sp^3$  (b)  $sp^3 > sp^2 > sp$   
 (c)  $sp > sp^3 > sp^2$  (d)  $sp^2 > sp > sp^3$
8. Among the following, the set of isoelectronic ions is [2013]  
 (a)  $Na^+$ ,  $Mg^{2+}$ ,  $F^-$ ,  $Cl^-$  (b)  $Na^+$ ,  $Ca^{2+}$ ,  $F^-$ ,  $O^{2-}$   
 (c)  $Na^+$ ,  $Mg^{2+}$ ,  $F^-$ ,  $O^{2-}$  (d)  $Na^+$ ,  $K^+$ ,  $S^{2-}$ ,  $Cl^-$
9. Among the following, the species with the highest bond order is [2012]  
 (a)  $O_2$  (b)  $F_2$  (c)  $O_2^+$  (d)  $F_2$

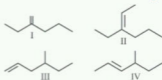
10. The molecule with non-zero dipole moment is [2012]  
 (a)  $BCl_3$  (b)  $BeCl_2$  (c)  $CCl_4$  (d)  $NCl_3$
11. The C - O bond length in  $CO$ ,  $CO_2$  and  $CO_3^{2-}$  follows the order [2012]  
 (a)  $CO < CO_2 < CO_3^{2-}$  (b)  $CO_2 < CO_3^{2-} < CO$   
 (c)  $CO > CO_2 < CO_3^{2-}$  (d)  $CO_3^{2-} < CO_2 < CO$
12. The bond order in  $O_2^{2+}$  is [2010]  
 (a) 2 (b) 3 (c) 1.5 (d) 1
13. The shape of the molecule  $ClF_3$  is [2010]  
 (a) Trigonal planar (b) Pyramidal  
 (c) T-shaped (d) Y-shaped

### Hydrocarbons

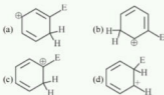
1. Among the following,



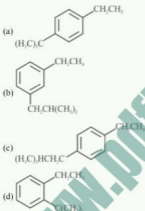
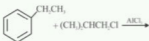
- the antiaromatic compounds are [2017]  
 (a) I and IV (b) III and V  
 (c) II and V (d) I and III
2. Which of the following alkenes can generate optically active compounds upon hydrogenation? [2017]



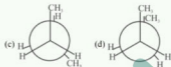
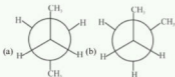
- (a) I, III and IV (b) II and III  
 (c) I and III (d) II and IV
3. In the reaction benzene with an electrophile  $E^+$ , the structure of the intermediate  $\sigma^-$  complex can be represented as [2012]



4. The major product of the following reaction is [2012]



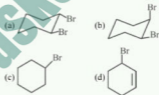
5. Friedel-Crafts acylation is [2010]  
 (a)  $\alpha$  acylation of a carbonyl compound  
 (b) acylation of phenols to generate esters  
 (c) acylation of aliphatic olefins  
 (d) acylation of aromatic nucleus
6. The most stable conformation for n-butane is [2010]



7. The aromatic carbocation among the following is [2016]

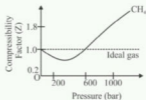


8. Cyclohexene is reacted with bromine in  $CCl_4$  in the dark. The product of the reaction is [2010]



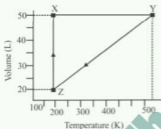
### States of matter

1. The ratio of root mean square velocity of hydrogen at 50 K to that of nitrogen at 500 K is closest to [2016]  
 (a) 1.18 (b) 0.85 (c) 0.59 (d) 1.40
2. In the following compressibility factor (Z) vs pressure graph at 300 K, the compressibility of  $CH_4$  at pressure < 200 bar deviates from ideal behaviour because [2016]



- (a) The molar volume of  $CH_4$  is less than its molar volume in the ideal state  
 (b) The molar volume of  $CH_4$  is same as that in its ideal state  
 (c) Intermolecular interactions between  $CH_4$  molecules decreases  
 (d) The molar volume of  $CH_4$  is more than its molar volume in the ideal state

3. The volume vs. temperature graph of 1 mole of an ideal gas is given below



The pressure of the gas (in atm) at X, Y and Z, respectively, are [2015]

- (a) 0.328, 0.820, 0.820 (b) 3.28, 8.20, 3.28  
 (c) 0.238, 0.280, 0.280 (d) 32.8, 0.280, 82.0

#### s-block elements

1. The thermal stability of alkaline earth metal carbonates -  $MgCO_3$ ,  $CaCO_3$ ,  $SrCO_3$  and  $BaCO_3$  follows the order [2017]

- (a)  $BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3$   
 (b)  $CaCO_3 > SrCO_3 > BaCO_3 > MgCO_3$   
 (c)  $MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$   
 (d)  $SrCO_3 > CaCO_3 > MgCO_3 > BaCO_3$

### ANSWER KEY

#### Thermodynamics

1. c 2. a 3. a 4. d 5. b  
 6. c 7. c 8. d 9. b 10. d  
 11. d 12. c 13. d 14. a

#### Structure of Atom

1. d 2. b 3. a 4. b  
 5. c 6. a 7. a

#### Chemical bonding

1. a 2. d 3. c 4. a 5. b  
 6. b 7. a 8. c 9. c 10. d  
 11. a 12. d 13. c

#### Hydro Carbons

1. b 2. a 3. d 4. a 5. d  
 6. a 7. c 8. a

#### States of matter

1. a 2. a 3. a

#### S-block elements

1. a

### HINTS & SOLUTIONS

#### Thermodynamics

1.Sol: For  $B \rightarrow C$

$$\Delta E = q + w$$

$$0 = q + w$$

or  $w = -q = -1$  L atm.

For  $A \rightarrow B$

$$w = -1(1.5 - 1) = -0.5 \text{ L atm.}$$

$$q = -w = 0.5 \text{ L atm.}$$

$$\text{Total Heat} = 1 + 0.5 = 1.5$$

2.Sol:  $N_2 + 3Cl_2 \rightarrow 2NCl_3$ ;  $N_2 + 3F_2 \rightarrow 2NF_3$

$$\Delta H = [6(200)] \quad \Delta H = [6(200)]$$

$$-[941 + 3(242)] \quad -[941 + 3(155)]$$

$$= -467 \text{ per 2 moles} \quad = -206 \text{ kJ per 2 moles}$$

$$\therefore \text{for 1 mole} = 233.5 \text{ kJ} \quad \therefore \text{for 1 mole} = 103 \text{ kJ}$$

3.Sol: At equilibrium,  $\Delta G = 0$

$$\Delta H = T\Delta S$$

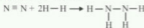
$$\Delta S = \frac{\Delta H}{T_{\text{avg}}} = \frac{6 \text{ kJ}}{273 \text{ K}} = \frac{6000 \text{ J}}{273 \text{ K}} = 22 \text{ J/K}$$

4.Sol:  $w = -nRT = -(1 \times 8.314 \times 10^3 \times 373)$

$$= -3.1 \text{ kJ}$$

$$q = \Delta H = 41 \text{ kJ}$$

$$\Delta E = q + w = (41 - 3.1) = 37.9 \text{ kJ}$$



$$\Delta H = (1 \times 946) + (2 \times 435) - (4 \times 389) - (1 \times 159) \\ = 101 \text{ kJ/mol}$$

6.Sol:  $\Delta S = 2.303 n R \log \frac{V_2}{V_1}$

$$= 2.303 \times 2 \times 8.314 \log \frac{100}{10} = 38.3 \text{ JK}^{-1}$$

7.Sol:  $\Delta U = 0$  and  $\Delta H = 0$

8.Sol:  $\frac{3}{2}KT = 1.6 \times 10^{-19}$

$$T = 1.6 \times 10^{-19} \times \frac{2}{3} \times \frac{1}{1.38 \times 10^{-23}}$$

$$T = 10^5 \text{ K}$$

9.Sol:  $\Delta H = 20 \text{ kJ/mol}$ , Now

$$\Delta E = \Delta H - \Delta n_{\text{gas}} RT$$

$$\Delta E = 20 - [8.314 \times 10^{-3} \times 333] = 17.2 \text{ kJ/mol}$$

10.Sol:  $w = -2.303 \times 3 \times 8.314 \times 10^{-2} \times 300 \log \frac{20}{2}$

$$= -17.2 \text{ kJ/mol}$$

11.Sol: It is second law of thermodynamics.

12.Sol: Entropy change will be positive due to dilution and enthalpy remains same.

13.Sol: At equilibrium,  $\Delta G^\circ = 0$

$$T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{7.5 \times 1000}{25} = 300$$



$$\Delta H^\circ = -1273 + (-286) \times 3 + 44 \times 3 - (-2035) \\ = 36 \text{ kJ}$$

#### Structure of Atom

1.Sol: Radial nodes =  $n - l - 1 = 4 - 1 - 1 = 2$

$$\text{Angular nodes} = l = 1$$

2.Sol: After losing first electron, it gets stability so  $IE_2$  is very high.

4.Sol:  $Mn^{2+} = 25 - 2 = 23$  electrons

$$Fe^{2+} = 26 - 3 = 23 \text{ electrons}$$

5.Sol:  $E = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{660 \times 10^{-9}}$

$$= 3 \times 10^{-19} \text{ J}$$

$$K.E. = 3 \times 10^{-19} - 1.6 \times 10^{-19} = 1.4 \times 10^{-19} \text{ J}$$

$$\lambda = \frac{h}{\sqrt{2mK.E.}} = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.4 \times 10^{-19}}}$$

$$= 1.32 \times 10^{-8} \text{ m}$$

6.Sol:  $\frac{\Delta E_{\text{exc}}}{\Delta E_{\text{ion}}}$

$$= \frac{\frac{1}{1^2} - \frac{1}{3^2}}{\frac{1}{1^2} - \frac{1}{2^2}} = \frac{32}{27}$$

7.Sol: We know that  $E = \frac{hc}{\lambda}$

$$E = \frac{6.6 \times 10^{-34} \text{ Js} \times 3 \times 10^8 \text{ m/s}}{1 \text{ m}}$$

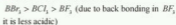
$$= 1.988 \times 10^{-25} \text{ J}$$

#### Chemical bonding

2.Sol: large difference in electronegativity.

3.Sol:  $NH_3$  is strong base and  $BCl_3$  is a strong Acid.

4.Sol: Acidity decreases in the order



5.Sol:  $O^{2-}, Mg^{2+}$  -10 electrons each.



7.Sol:

$$\left. \begin{array}{l} sp \rightarrow s - \text{character} - 50\% \\ sp^2 \rightarrow s - \text{character} - 33\% \\ sp^3 \rightarrow s - \text{character} - 25\% \end{array} \right\} \begin{array}{l} \text{Greater} \\ \text{'s' character,} \\ \text{higher is the electronegativity} \end{array}$$

8.Sol:  $Na^+, Mg^{2+}, F^-, O^{2-} = 10$  electrons each.

9.Sol: B.O. of  $O_2 = \frac{10-6}{2} = 2$

$$O_2^+ = \frac{10-5}{2} = 2.5$$

$$F_2 = \frac{10-8}{2} = 1$$

$$F_2^+ = \frac{10-9}{2} = 0.5$$



Due to lone pair on nitrogen,  $\mu \neq 0$

11.Sol: CO has triple bond,  $CO_2$  has double bond &  $CO_3^{2-}$  has resonance of single and double bonds. Bond Length: single bond > double bond > triple bond.

12.Sol: Bond order of  $O_2^{2+} = \frac{10-8}{2} = 1$

13.Sol: T-shaped -  $sp^3d$  - 2 lone pairs.

### Hydrocarbons

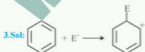
1.Sol: III and V have  $4\pi$  electrons so are antiaromatic.

2.Sol: (i) gives chiral carbon

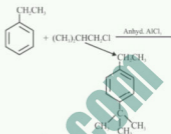
(ii) gives No chiral carbon

(iii) gives chiral carbon

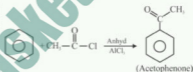
(iv) chiral carbon



4.Sol: Rearrangement of carbocation takes place.



5.Sol:



6.Sol: The most stable form is anti-form.

7.Sol: (a) Option  $\rightarrow$  Anti-aromatic  
(c) Option  $\rightarrow$  Aromatic

8.Sol: Anti addition takes place.

### States of matter

$$(u_{rms})_{H_2} = \sqrt{\frac{3 \times R \times 50}{2}} = 1.18$$

1.Sol:  $(u_{rms})_{O_2} = \sqrt{\frac{3 \times R \times 500}{28}}$

3.Sol: Pressure at X =  $\frac{nRT}{V} = \frac{1 \times 0.0821 \times 200}{50} = 0.328$

Pressure at Y =  $\frac{1 \times 0.0821 \times 500}{50} = 0.821$

Here at Z =  $\frac{1 \times 0.0821 \times 200}{20} = 0.821$

### s-block elements

1.Sol: Thermal stability of carbonates increases down the group.

# CHEMIS

# TRICKS

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## ROUGH CALCULATIONS

It is very common to appear 6 to 10 numerical based questions in **CHEMISTRY** in **N.PET, JEE mains**, state level Entrance exams like **KCET, EAMCET**. This type of questions appear frequently from the topics Atomic structure, States of matter (Gas & solid), Thermodynamics, Equilibrium (chemical & ionic), Solutions, Electrochemistry, Kinetics and Organic chemistry (quantitative analysis).

Though student knows the formulae, it takes little time for substitution and more time for calculation (multiplication & division). You should remember that "time saved is time produced". Top ranker to bottom ranker are allotted same time. Those who think differently, accurately, within shorter period can only win the race.

If a numerical based question involves two formulae it takes much time. As "JEE" stream students will have to answer about 70-80%, "NEET" aspirants will have to answer about 25% numerical based m.c.q.s, they must think of rough calculation techniques.

**Ex:1** Calculate longest wavelength in Hydrogen spectrum of Lyman series

$$\frac{1}{\lambda} = R_H \left[ \frac{1}{1^2} - \frac{1}{2^2} \right] = \frac{3}{4} R_H$$

$$\therefore \lambda = \frac{4}{3 R_H} = \frac{4}{3 \times 109677}$$

$$= \frac{4}{3} \times 912 \text{ Å} = 1212 \text{ Å} \text{ (rough calculation)}$$

$$= 1215.7 \text{ Å} \text{ (Exact calculation)}$$

(Trick:  $\frac{1}{R} = 912 \text{ Å}$ )

**Ex:2** Calculate the pressure (in atm) exerted by 1.75 moles of a gas at S.T.P.

$$P = \frac{nRT}{V} = \frac{1.75 \times 0.0821 \times 273}{22.4} = 1.75 \text{ atm}$$

(Trick:  $0.0821 \times 273 = 22.4$ )

without this clue (Trick or shortcut) calculation takes lot of time, if a question asked other than S.T.P. conditions.

**Ex:3** Calculate the number of moles of oxygen present in 10L cylinder at 4atm pressure and 17°C temperature.

$$n = \frac{PV}{RT} = \frac{4 \times 10}{0.0821 \times 290} = \frac{4 \times 10}{24}$$

$$= 1.66 \text{ L (rough calculation)}$$

$$= 1.68 \text{ L (exact calculation)}$$

**Trick:** As T is more than standard temperature (0°C), we have to take RT value a little bit more than 22.4L (i.e., take 24 lit).

**Ex: 4** If  $K = \frac{1.29}{520}$

You have to multiply it by 1000 and divide by 1000 for easy cancellation of 520

$$\therefore K = \frac{1.29}{1000} \times \frac{1000}{520}$$

$$= 2.6 \times 10^{-3} \text{ (rough calculation)}$$

$$= 2.48 \times 10^{-3} \text{ (exact calculation)}$$

**Trick:** Some how try to get 10, 100, 1000 numbers in the denominator and cancel accordingly.

**Ex:5** In 69.3 min, a first order reaction is 50% complete. How much reactants are left after 161 min?

(a) 80% (b) 40% (c) 20% (d) 60%

**Sol: (c)** By applying formula, it takes lot of time. So follow this logic.

100%  $\xrightarrow{69.3 \text{ min}}$  50%  $\xrightarrow{69.3 \text{ min}}$  25%  $\xrightarrow{69.3 \text{ min}}$  1.25%  
(Initial) (Left)

By observing options 20% is correct, as 161 min is in between  $2 \times 69.3$  and  $3 \times 69.3$ .

Usually students become nervous by seeing log based questions. In general such questions appear from Thermodynamics, Ionic equilibrium, Kinetics, Electrochemistry.

To solve these questions one must know the log and anti log values in simple manner.

$$\log 1 = 0$$

$$\log 2 = 0.3010$$

$$\log 3 = 0.4771$$

$$\log 5 = 0.6990$$

$$\log 10 = 1$$

you can guess log 4 and log 9 easily, log 6, log 7 log 8 can be guessed as follows.

$$\begin{aligned}\log 4 &= \log 2^2 = 2 \log 2 \\ &= 2 \times 0.3010 = 0.6020\end{aligned}$$

$$\begin{aligned}\log 9 &= \log 3^2 = 2 \log 3 \\ &= 2 \times 0.4771 = 0.9542\end{aligned}$$

**Trick:** For log 6 to log 8 (add 0.07 for log value of previous number)

$$\begin{aligned}\log 6 &= \log 5 + 0.07 = 0.6990 + 0.07 \\ &= 0.77 \text{ (rough)} \\ &= 0.7782 \text{ (exact)}\end{aligned}$$

$$\begin{aligned}\log 7 &= \log 6 + 0.07 = 0.77 + 0.07 \\ &= 0.84 \text{ (rough)} \\ &= 0.8451 \text{ (exact)}\end{aligned}$$

$$\begin{aligned}\log 8 &= \log 7 + 0.07 = 0.84 + 0.07 \\ &= 0.91 \text{ (rough)} \\ &= 0.9031 \text{ (exact)}\end{aligned}$$

You can go ahead with rough calculations based on logarithms.

**Anti log values:**

Anti log values are nothing but the reverse of log values.

$$\text{Anti log of } 0.00 = 1$$

$$0.30 = 2$$

$$0.48 = 3$$

$$0.60 = 4$$

$$0.70 = 5$$

$$0.77 = 6$$

$$0.84 = 7$$

$$0.90 = 8$$

$$0.95 = 9$$

**Ex:6** Calculate pH of 0.25M aqueous solution of boric acid. ( $K_a = 5.9 \times 10^{-10}$ )

$$H^+ = \sqrt{K_a \cdot C} = (K_a \cdot C)^{\frac{1}{2}}$$

By taking -log on both sides

$$-\log[H^+] = -\left[\frac{1}{2} \log K_a + \frac{1}{2} \log C\right]$$

$$pH = -\frac{1}{2} [\log(5.9 \times 10^{-10}) + \log 0.025]$$

$$= -\frac{1}{2} [\log 5.9 + \log 10^{-10} + \log(2.5 \times 10^{-2})]$$

$$= -\frac{1}{2} [0.76 - 10 + 0.4 - 2] = -\frac{1}{2} (-10.84)$$

$$= 5.4$$

(Hints:  $\log 5.9 = \log 6 = 0.77$ )

log 2.5 value is in between log 2 and log 3, hence take log 2.5 as 0.4)

$$\text{Ex: 7 } \log_{10} K_c = \frac{nFE'_{\text{cell}}}{0.0591} = \frac{4 \times 0.16}{0.0591} = 10.8$$

$$\therefore K_c = 10^{10.8} \text{ or } 10^{10} \times 10^{0.8} = 6.3 \times 10^{10}$$

$$\text{Anti log of } 0.8 = 6.3$$

(0.8 is in between 0.77 and 0.84 as closer to 0.77 hence Anti log of 0.8 = 6.3)

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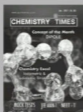
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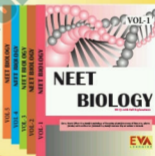
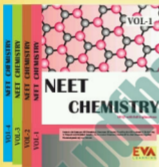
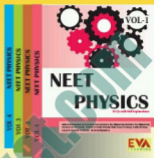


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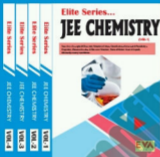
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